MADRAS FISHERIES BUREAU

BULLETIN No. I

I.C. 2675

MADRAS FISHERIES BUREAU.

PAPERS FROM 1899

RELATING CHIEFLY TO THE DEVELOPMENT OF THE MADRAS FISHERIES BUREAU.

VOLUME I—BULLETIN No. I.

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PREFACE.

BULLETIN No. I is an anachronism, being first by designation only and not by date. When Bulletins became a necessity for the record of important enquiries, it was intended to gather together a few of the earlier papers showing the origin of what was, at first, a mere investigation into the existing fishery industry of the Presidency started in view to obtain data for assisting the development of the indigenous industry. For various reasons, however, the issue of No. I was delayed while several contemporaneous Bulletins were issued with later numbers, and as the work of investigation developed No. I fell into oblivion. But since Government now desire its issue and since administrative and industrial changes are imminent, the belated Bulletin has been compiled, and advantage has been taken of the delay to make it, not a mere record of origin but, in a sense, a history of the development of the investigation into a Bureau or Department. Hence the Bulletin consists almost solely of original papers in whole or in extract, showing from 1905 to 1915 the changes and development of ideas, the proposals made from time to time, and the orders passed thereon. It is hoped that this conspectus of the past will provide useful help for the future.

It will be seen from the papers that the local enquiry of 1905–06 largely gave way to enquiry by experiment in 1907 and later years, and that the single amateur investigator of 1905 was strengthened, and, on main

lines of enquiry and operation, advantageously replaced by expert specialists from 1907 and 1908.

For it was soon found that while the local enquiry readily yielded a mass of fairly obvious facts relative to indigenous methods and conditions, yet that a far deeper and more lengthy investigation was needed to yield answers to the questions why such methods prevailed; what were the conditions, whether of nature or of society, which limited or compelled these methods; what practical improvements in existing methods could be devised and inculcated as sure and certain; how such improvements could be introduced and popularised; what developments, hitherto undreamed of,—piscicultural, industrial, commercial, scientific, economic and social—were both desirable and feasible.

Nothing but such continuous industrial experiment as put the investigator into the position of the fisherman and curer, taught him the natural, economic, and social difficulties of their business, and led him by superior knowledge and power of research into the paths of practical improvement, could be of real worth; it is only the intimate knowledge gained by continuous practice under the conditions of the country that could produce suggestions of permanent value. This will, in a measure, be evident from the papers read as a series, which not only display the changes in idea and method which have characterized the work of the department but the mistakes which were necessarily made by inexpert enquirers when investigating an industry of which the conditions and limitations imposed by nature and by social and economic history were absolutely untested.

The papers are, except for the correction of a few surface errors, printed as they were originally written; they are mostly extracts and not entire papers, since

much of the original matter was of ephemeral or collateral interest.

Bulletin No. IX, now mostly in the press, will contain extracts from the annual reports made to Government up to the current year; these will show the operations actually undertaken and the progress made in translating ideas and proposals into fact. The final paper in that Bulletin will contain suggestions based on the experience of the past ten years.

5*th September* 1915. F. A. NICHOLSON.

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MADRAS FISHERIES BUREAU.

BULLETIN No. I.

EXTRACT FROM AN OFFICIAL NOTE OF 1899 ON THE DESIRABILITY OF DEVELOPING THE AGRICULTURAL DEPARTMENT. *

Fisheries.—No bureau of the proposed department will exceed this in importance. The development of our fisheries is now *absolutely essential* in connection, whether direct or indirect, with our food-supply: when we despair of food independent of climate for a rapidly-increasing population, of industries for non-agriculturists, of manure for deteriorating soils, we may thank God that we have yet got the fisheries to develop. This all important subject has too long been neglected; the sea yields its harvests in enormous quantities wholly irrespective of droughts and seasonal catastrophes, and the food, being highly nitrogenous and concentrated, is of extreme value. Hardly less important are the bye-products, viz., manure, oil, etc. In most countries, e.g., Italy and Germany, this subject in its entirety is confided to a bureau of the Agricultural Department: while, in practically every country, that branch of it which deals with pisciculture (*aquiculture*, to use a French term) is handled by this department, as in France, Austria, etc. In this Presidency, where it has been recognized by Government that it will *primarily* be treated not as a source of revenue, but as a means of increasing the food-supply, the manurial resources, and the petty industries of the country, it is obviously the Agricultural Department which should deal with it.

The subject is so vast and so important that it will require years of absolutely continuous study, experiment, stimulus, and assistance before it can be set on a sound basis, but general lines of work may be indicated. It may, however, first be pointed out how this subject emphasizes the necessity for a department which shall make such matters, whether agriculture or aquiculture, its sole and continuous business; nowhere is the uselessness of individual or spasmodic effort, the waste of time, brains, knowledge and labour better exemplified than by this subject. From before 1870 and almost continuously after it, Mr. H. S. Thomas with Dr. Day ceased not to urge the importance of the fisheries of India, mainly in connection with the food-supply †; the works and scattered papers of these officers are conclusive and

* This extract has been cut down and slightly corrected from the original.

† See Mr. Thomas' Memorandum to the Famine Commission of 1878—80 on Fisheries in connection with Food-supply.

were accepted as such by the Government of Madras between 1872 and 1888; Mr. Thomas drafted two if not three Fisheries Bills and supported them with his well-known enthusiasm. But there was no department to be influenced by his enthusiastic labours or to carry on his work, and now, save for an "Indian Fisheries Act" (1897), we are just where we were when Mr. Thomas left the country, except that we have lost many years of time and his experience and knowledge. Had there then been an Agricultural Department with fisheries as one of its permanent Bureaux, this great subject could not have dropped almost into oblivion as it has, save for a few fish-curing yards, in the absence of practical interest and continuous policy.

Sea Fisheries.—These are already of some importance, but are even less developed than local agriculture; they have had neither attention nor capital devoted to them, and, as Mr. Thomas says, bear about the same relation to British fisheries, as a catamaran does to a steam trawler. For instance there is no deep sea fishing; the boats are usually of the catamaran or canoe class, and night fishing is not general; the boats usually start in the morning and return in the evening and the practice of staying out for weeks is impossible. Yet it is certain that the Indian seas swarm with valuable fish, the hauls obtained even by the coast fishermen show this. In the Madras coast line of about 1,750 miles (inclusive of Travancore and Cochin) there must be fishing grounds of above 30,000 square miles or 20,000,000 acres, the fish life of which in tons is incalculable. At one cwt. per acre per annum the produce would give 1,000,000 tons per annum or about the same as that—including shell fish—now brought annually into Great Britain. When we remember that Great Britain is principally a meat-eating country, that it imports other edibles to the annual amount of £160,000,000 and that its manurial as well as its food-supply depends but moderately upon its fisheries, it may be assumed that in this Presidency, where 90 per cent. of the population will eat meat and fish but are unable to obtain such diet in sufficient quantity, a supply of 1,000,000 tons would *easily* be consumed. The enormous importance of even a million tons of fish will be seen by the following facts: assuming that one-half of the above is not actually edible, the remaining half million tons will give about two ounces of highly nutrient food *per diem* to 25,000,000 people for a year, while the remainder as offal, bones, non-edible fish, etc., would yield valuable manure sufficient, of its class, for probably 5,000,000 acres. To these considerations may be added the additional employment given to myriads of the fishing class and to those employed in the connected industries of boat-building, net-making, curing, manure-making, oil-extracting and the like, while there would be a large addition to the demand for salt and to the carrying and other trades of the country.

This is not the place to indicate the methods of developing the vast possibilities of this branch, which will demand the building of large fishing-smacks (such as the dhonies and pattimars of the coast)-*probably with salt water wells, as in some English fisheries, to enable boats to keep the sea for days together and yet to bring back their catches alive*, the employment of capital, and a considerable amount of assistance

and organization ; these details will obviously require the continuous attention of the Fisheries Bureau. It may be suggested, however, that the action of the Irish Fishery Board in the Congested Districts, which will be extended to the whole of Ireland by the Agricultural Department newly (1899) constituted, will form a convenient example for study by the Madras Department, which will seek to stimulate and assist private effort, whether by individual capitalists or by associations, under proper regulations for the quality and wholesomeness of the resulting food-supply, and the safety of the Salt revenue. Probably it will be found advisable to develop this branch in direct connection with the bonded fish-curing yards as centres, or conversely to establish such yards at any centre where the fishing industry is likely under such stimulus to develop.

The Congested Districts Board has provided technical instruction, e.g., by bringing Scotch fishermen, coopers, boats, etc., to the Irish coasts to teach new fishing, boating and curing methods, has started curing stations, advanced loans for boats, nets and other apparatus, has induced the starting of fisheries wholly new as to time and place—e.g., a spring mackerel fishery at Arran, etc.,—encouraged the cooperage, net-making and other industries connected with fishing, and has also done much to open out markets for the fish thus brought to market · the results, though they have occasionally caused slight loss to the Board, as sometimes happens in first efforts, have been highly successful for the fishermen and for the industry, though efforts are of recent date. Trade schools have been started in which boys and girls learn net-making and mending, and in other ways the industry is being encouraged. A scientific survey of the fishing banks and deep-sea fishing grounds round the coasts is now beginning, in which it is expected to obtain a proper knowledge of the habits, time and places of spawning, migration, food-supply, etc., of the fish, as has been thoroughly done long ago by the Scottish Fisheries Board. It is believed that the Madras Government has now initiated some enquiry in this direction, but a survey to be of use must be thorough, and carried out by competent men with time and means at their disposal and without a dozen other matters on their hands. The harvest of the sea is well worth the expenditure of a few thousands of rupees and is a necessity of this time.

Estuary and River Fisheries.—On this complicated question I need only refer to the existing files on the subject : this branch is extremely important since these fisheries already supply large quantities of fish, and are free from many of the difficulties attending deep-sea fishing. But the present supply is trifling compared with that which a proper system of *mere conservation* would develop, altogether apart from the productiveness of these waters, under a system of culture and special protection as in the rest of the civilized world, where there are close times, and hatcheries which annually put out hundreds of millions of fry and are yet only at the beginning of their work. But the subject is complicated owing to the habits of the fish and customs of the country, the nature of the rivers and the irrigational use made of them ; the provision of fish passes in the anikats—as in the Cauvery, Kistna, etc.—is only one of the difficulties. Mr. Thomas has, however, dealt with the several difficulties

and points out that success means a great addition to the food-supply *brought to the doors of the people* in the tanks and channels.

Inland Water Fisheries.—Under this head which, however, by its title covers much of the river fisheries, are included a totally different and very simple class of fishery, viz., that of backwaters and lagoons, reservoirs, tanks and ponds, devoted wholly or in part to deliberate food production ; to aquiculture in fact. This system, in vogue in ancient Egypt and extensively practised at this day in China where the pressure of the inland millions demands more nitrogenous food than the soil can supply, is now recognised in western countries, and is believed to give a far greater equivalent of food per acre than a similar area of soil. Some such system is become a necessity in inland India where there are already lakhs of acres of comparatively unproductive waters, besides possibilities for additions to the productive waters. For instance, there are vast reaches of permanent water behind many of the anikats, as in the Bhaváni above the anikat at the town of that name ; there are hundreds of square miles of shallow backwater as at Pulicat, Ennore, etc., and of "rivers" such as the now sewery Cooum and the Adyar : there are lakes and tanks, such as the Red Hills tank and a vast tank on the Kurnool canal, which do not dry up during the year ; there are myriads of large irrigation wells in which the owner might keep a few fish for his own supply.

There are many low-lying and even swampy places by the side of rivers, channels, and streams, or at the lower end of an irrigation area, which are, by their position, useless as irrigation tanks, and into which flood-surplus or drainage waters could be turned with ease from the fact of their lying low ; these would, if properly excavated, retain water the whole year through. Many a tank might be so deepened as to retain water throughout the hot season sufficient to keep a stock of fish alive, and in many private tanks, especially near towns, it would probably pay to retain the whole water as a stock pond, cultivating the hitherto irrigated ayacut as dry land or by means of wells ; in Bengal the practice of keeping stock ponds, fed by duly purchased irrigation water, is found to be a paying business : it is even probable that pools fed from wells might be used with advantage as breeding grounds and stock ponds. Mr. Thomas gives an instance from his own experience (Indian) which should be published : a pond of 2 or 3 acres was under clearance, and was stocked by him at a total expense of Rs. 2 with selected fish-fry, care being taken to exclude those of the *predatory* class ; no food, except a few snails at the time of stocking, was supplied and 18 months' rest was given. From that time "more than 4,000 lbs. of fish were annually taken out of the pond "without making any impression on it." This was the result of careful selection, non-predatory fish being alone stocked. The experience of other countries is similar. Even the ordinary tanks of the country might be made, with care, to breed more fish than is now the case.

A perusal of the detailed papers and consideration of the facts mentioned in them and in the above sketch show not only the enormous and pressing importance of the fisheries question, but also that it can only be dealt with by a permanent department, which, by reason of its connection with the food-supply and agricultural interests,

should be a branch of the Department of Agriculture. It is so vast and at the same time so complicated, and deals with such ignorant masses of people, and yet requires the intelligent acceptance of such new ideas and methods, that only the most continuous, untiring, and tactful efforts of experts can bring about success ; no useful results can arise from the intermittent efforts of languid general interestedness ; men must take it up whose sole business it will be under the general direction of a permanent department. Probably there are officers in the various services, Marine or other, who are capable by past study and experience, of taking up the question of sea-fisheries, and it may be that there are ichthyologists, budding or mature, who will add knowledge and enthusiasm to such experience of the country and people as will enable them at once to begin work at the development of inland fisheries : this can be ascertained if a Fishery Bureau is organized. In all cases it would seem that the bureau should associate with it an Advisory Board composed of scientific and practical experts such as men of the stamp of Dr. Thurston, the Superintendent of Chank and Pearl Fisheries, men engaged in the fish-oil and manure trade, heads of fishing classes such as the hereditary chief of the Tuticorin fishermen, etc. The bureau, even though not worked for revenue, could easily be made to pay all expenses, and it will be remembered that considerable sum—above a lakh—is already derived from tank and river fisheries in this Presidency, the proceeds of which ought to be expended in developing this all-important industry and food-supply. The proceeds of fisheries are at present handed over to Local Funds, having been given to them in 1864 when Local Funds were merely items of miscellaneous improvements under the Collector : there is absolutely no reason why these fish-rents should now go to Local Boards and merely swell their resources without return to the fisheries. If this source of income is continued to them, they should be compelled to spend it in developing local fisheries.

EXTRACT FROM A SCHEME FOR THE DEVELOPMENT OF FISHERIES, 19TH JANUARY 1905.

* * *

9. Though at least 75 per cent. of the Madras people will eat fish if they can get it and though such food is most nutrient and, when fresh or properly prepared most wholesome, yet, as a fact, the internal fish supply of the country is of the scantiest and most insufficient character, while its quality, often semi-putrid, causes it to be often unwholesome and possibly the cause of more than one disease. Again while the fields are infertile or less fertile than they should be for want of manure, one great source of such manure, viz., the sea fisheries, is left almost unworked. Now to remedy the above defects we need, in India, to work in two opposite directions ; *inland* we require to protect fish, to hinder reckless destruction, to add largely to the productiveness of existing waters, and to develop modes of stocking waters at present unused ; for *marine* fisheries we need to develop in every way the modes of entrapping the immense but almost unused wealth of the sea and of placing the increased catches in good condition upon the inland markets. If reports are true, and they are confirmed by casual observation, the inland sources of fresh-water fish, scanty in most places as a food-supply, are in process of exhaustion and destruction by combined recklessness and ignorance, while, on the other hand, the illimitable resources of the sea are exploited in the most primitive of fashions ; as has been rightly said, the apparatus and methods of the fisherfolk bear just the relation to Western methods and, it may be added, to the existing, and still more to the future, needs of this country that the catamaran bears to the steam trawler. *Inland* or on the backwaters, save perhaps on the Nilgiris, there is not only no attempt at pisciculture or even at conservation, but the only principle adopted throughout is to catch and destroy everything that swims from the fry weighing 20 to the ounce upwards ; wilful destruction by poison and explosives is said to be common, while in the dry weather the river-pools and the tanks are netted clear of every sort of fish that can be got into the nets. As for methods of checking such blind destruction, such carelessness of the future, they are not even in contemplation, while developments now common to civilized countries such as the artificial propagation of fish in hatcheries and the restocking therewith of inland waters, are absolutely unknown. As for the marine fisheries the fishermen are ignorant and poor, they scarcely venture to pass 24 hours at sea, since their boats are generally small and primitive and they have no means of preserving their catches ; the drying and salting of the fish is crude and the product unsatisfactory. It is true that the fish-curing yards under the Salt Department are doing good and increasing work, but these hardly tend to increase the quantity of fish caught or to develop the ability and methods of the fishermen in catching the fish and bringing them alive to the curing yards, nor are new methods taught of curing the catches such as are found necessary even in temperate

climates. I allude, for instance, to the development of fishing boats capable of staying at sea for days together and provided with wells for retaining the catches alive indefinitely, the provision of trawl nets to be used with such boats for securing better catches of better fish from greater depths, the methods of drying, smoking, and packing fish for inland transit, and so forth.

* * *

20. Finally it is suggested that each successive famine or scarcity or threat thereof only accentuates the necessity—the urgent necessity —for additional supplies of food otherwise than from the uncertain fields; each successive year increases the normal pressure upon a naturally poor and hard-pressed soil and therefore the need for more food and more manure *ab extra;* each successive year the fish in inland waters tend to disappear with the greater inroads and demands made upon them. Happily the sea is almost untouched and by a proper development of marine fisheries alone we can add to the produce of our fields on land the almost inexhaustible harvests of an area which, within only 30 miles from the Madras shores, includes 30 million acres of productive water.

* * *

ORDER—NO. 487, REVENUE, DATED 29TH MAY 1905.

APPOINTMENT OF A TEMPORARY FISHERIES OFFICER.

Under the sanction of the Government of India, His Excellency the Governor in Council is pleased to depute Sir F. A. Nicholson, K.C.I.E., to investigate the fishery industry, both inland and marine, in the Madras Presidency.

FISHERIES INVESTIGATION REPORT FOR THE QUARTER ENDING THE 31ST DECEMBER 1905.

The first few days of October were spent in arranging papers, information, etc., and on the 19th idem I left for a tour on the West Coast, which lasted till December 14th ; my Assistant, after the close of the Special Tests examination at which he appeared in compliance with Government orders, investigated the fisheries at and near Madras. This report will deal almost solely with the West Coast, since the East Coast will be taken up from January.

Places visited.

2. The places visited were Calicut, Badagara, Tellicherry, Cannanore, Hosdrug, Kasaragod, Manjeshwar, Mangalore, Cochin, and Tanur. A mass of information has been obtained regarding fishing and curing methods, apparatus, customs, the relation of labour to capital, of fishermen to curers and of curers to the trade, the fish-curing yards, the character of the ports and harbours ; regarding, in short, the economic and industrial sides of the industry : enquiries have also been begun on the seasons of fishing for various fish, the best general conditions (wind, current, etc.) for fishing, the spawning periods, the appearance or absence of shoals, the maturity or otherwise of fish caught, and so forth. The whole information is now being ledgered under the proper heads from my note-books. A series of detailed questions (copy appended), based partly on the experience of this and previous tours, has also been printed for distribution to persons likely to be interested or to aid in making similar enquiries : the questions are intended as general guides and not as hard and fast questions.

Difficulties of obtaining information.

3. The obtaining of correct information is neither easy nor speedy ; the language difficulty itself is great, since not only are the fishermen's dialect and technical vocabulary hard to follow even by one who knows the language well, but it may be on the West Coast either Malayalam, Canarese, Tulu, or Mahratti, while translators are not always either accurate or intelligent. The fishermen, moreover, though willing

and communicative, are ignorant and often unable to put explanations or descriptions into clear words, while even in the facts they are often quite inaccurate from ignorance or from loose habits of observation or narration ; e.g., they may allege that boats fish at 12 or more miles from shore, while enquiry shows that the huts on the beach are visible from the boat which is on the sea level ; it has been alleged (Palk's Straits on the East Coast) that fish were caught at 15 to 18 fathoms when the maximum depth of that sea is 8 or 9 fathoms. The safest and most fruitful method is to sit patiently with them in their boats, or on the beach, observing, and asking questions casually and infrequently so as not to worry or frighten them ; but this is necessarily a lengthy if accurate method. However, during the many scores of hours spent with the fishermen at sea, or on the beach, or in the curing yards or with curers and merchants, it is believed that not only has good information been obtained but that a good deal of suggestive information has also been imparted especially in matters relating to the catching and preservation of fish in other countries.

Scientific enquiries.

4. The scientific part of the enquiry such as the identification and correct naming of the various fish in the several languages, the examination of their habitat and of their food supplies, the ascertainment of their spawning grounds and of the character of their ova, and other matters of scientific observation will be begun (it can, of course, only be *begun*) after the next south-west monsoon when a second tour will be made there with my Assistant ; meanwhile the questions above alluded to will probably result in a further mass of information. Much attention will necessarily be paid to the West Coast where the trade and industry are so much more vigorous than on the East Coast and capital more ready for investment.

5. Several matters come prominently into view in such a tour : they will merely be adverted to here, and will be dealt with at length in the final report.

General weakness of exploitation of the sea with causes.

6. The first is the weakness of the exploitation of the sea hitherto made even on the West Coast which, as gauged by the fish-curing yards, yields above thrice the fish caught on the eastern side of the Presidency

though the latter has a sea coast four times as long as that of Malabar and South Canara. The area between Cape Comorin on the south and the northern boundary of South Canara is about 17,000 square sea miles (of 2,000 yards to the linear mile) within the 100 fathom limit, and above 6,000 square miles within the 30 fathom limit: this includes the waters which wash Travancore and Cochin which are, of course, open to fishing. Only the fringe of this area is worked and that only in a small way; little or nothing beyond the 10 fathom limit is touched save in the South Canara waters by a few comparatively large boats which come from the Bombay Presidency. Some of the main reasons are the smallness and inability of the boats, which, except for a few Bombay boats, are merely canoes (dug-outs), to keep the sea for more than a few hours; the consequent waste of time in the daily journeys to and fro when the boats go out beyond the 3-mile limit; the consequent disinclination to go much beyond that limit; the numerical deficiency in boats and men; the large number of men necessarily employed per canoe or net and the consequent inefficiency of labour [e.g., two crews of seven men each in two boats to work one quite moderate sized dip net (odam) as compared with less than that number in the big European boats with their large fleets of nets]; the numerous causes, advanced or valid, for not going out to fish, such as the state of the moon, wind, or currents, the presence of the monsoon, the non-appearance, inshore, of shoals, the festivals or fasts, the heavy and well-paid demand for labour and boats in loading and unloading the steamers and shipping at the larger ports. These and other reasons will be dealt with below and more completely in my final report.

Description of boats and results of smallness of boats.

7. The boats are merely dug-outs or shells of various sizes, sometimes flat-bottomed, holding from 2 to 8 men and costing up to Rs. 500; the largest may be about 32 feet long, 3 wide, and $2\frac{1}{2}$ deep: there is no room in the boat for any but the most restricted movement, nor is it possible to fit them with any sort of mechanical gear; all work must be done and power applied by manual dexterity acting in a very limited space on a very crank platform. Each boat is usually fitted with a simple sail, but in Tanur the large flat-bottomed boat

seldom has sails but, when the wind is favourable, adopts the crude method of fastening a couple of oars upright with three or four of the boatmen's garments as sails. The result is that the nets in use are necessarily of limited capacity; limited by the small carrying power of the boats and by the manual power of the men acting on these awkward platforms, while only one set of nets can be taken out at a time so that if men are fishing for one class of fish and shoals of different sized fish appear, they are often unable to take them; moreover, since it passes men's endurance to spend more than a few hours at a time daily in such craft, the duration and distance of the voyages are limited. Yet again, the small size and capacity of the boats forbids any attempt to keep fish alive by wells or water chests, or to salt the fish down in the boat even if cheap salt were available which is not the case; hence fish have often been dead for several hours before reaching shore, and deep-sea catches are frequently tainted and seldom really fresh, so that fish cannot be taken far inland, while the portion which goes to the curing yards, often after considerable further delay on the beach or in preparation for the curing yard, is often tainted before the curing process begins, a fact necessarily detrimental both to the wholesomeness and market value of the product. Conversely, the want of knowledge how to keep fish alive and fresh in wells or chests and the inability to obtain cheap salt for the proper salting down of the fish at sea and the ignorance of the methods or the absence of the practice of preserving fish wet in pickle, tend to keep the boats small and the voyages short. There are in practice the germs of the carrier system by which special boats bargain at sea with the fishing boats and bring the catches somewhat sooner to shore, but this only takes the form of small canoes of neither speed nor capacity, usually chartered or owned by small fish dealers with a little ready cash: they seldom go out above a mile or two.

The failure to discover shoals, possibly due to smallness of boats.

8. A regrettable result of the smallness of the boats is that shoals are obviously missed, as in this year, because the boats cannot go out to sea to look for them; the men wait on or near shore and hope for shoals: if shoals are not seen it is concluded that they have

not come, whereas they may merely be out a little further. The steamer in which I returned from Mangalore passed, said the Captain, just north of that port and at 10 or 12 miles from land, through shoals which extended "as far as the eye could see," and I personally saw smaller shoals at 5 or 6 miles out; yet none came inshore or were taken by the fisherman at that time. With large boats able to keep the sea, it would be possible to reconnoitre for shoals, to follow them when found, and either to salt them on board (see paragraph 15) and take them to shore at intervals, or to send them in daily by carrier boats (paragraph 14), or to keep the larger fish alive in wells (paragraph 13).

The necessity for larger boats.

9. The large boat question is intimately bound up with the future of the industry on modern and necessary lines: by "large" boat is here meant a good-sized boat of a few tons, decked if possible, and able to keep the sea for some days together; it is not intended to suggest necessarily the big smacks of from 30 to 50 tons found in England and elsewhere, but rather those found in the Adriatic and Mediterranean, or boats of or improved from the Ratnagiri pattern which latter are common in South Canara in the cold weather and some of which keep the sea for some days when fishing, while all have, necessarily, to make the 300-mile voyage from Ratnagiri and those parts. It is only with such boats that a crew can do proper work; it is absurd to see seven men crowded in a small, crank canoe working a small net (or rather a pair of canoes with fourteen men) when the same seven men could work a big smack and thus use the mechanical aids and employ the powerful nets which are demanded for the proper exploitation of the sea: it is only such boats that can stay at sea for several days together, or in which it is possible to use live wells, salt, or preservative processes.

Reasons advanced for not building larger boats.

10. Now the reasons advanced against building such boats are not many; it is not customary; the fishermen are not used to stay at sea; such boats are costly; the fish cannot be kept from putrefaction. These are the only reasons advanced: there is no fear of the sea or of sudden storms; it is one great advantage of our coasts that we have regular, known, and predictable weather

for each month in the year and for several zones of the sea, and that there are few surprises outside the well known periods and localities of cyclonic storms.

Reasons discussed.

11. Of the above objections the first two may be lightly passed over: custom will give way, as it has already done in the case of new-fashioned nets, before advantage and profit; and we have, in fact, the Ratnagiri boats coming in larger numbers further south each year (so enquiry seemed to show) which are excellent object lessons both as to size and habit of staying at sea: moreover the coastal trade is carried on in a variety of craft of all sizes the crews of which are well accustomed to the deep sea and long voyages.

Provision of capital for larger boats.

12. The third reason is good in so far as we hold to the idea of the independent fisherman each with his own boat, but, in fact, the industry is tending to develop, as in western countries, towards the disappearance of the independent boatman and the entry of the capitalist-employer: at Tellicherry, one of the best fishing and dried-fish centres, two curers control two-thirds of the numerous boats: on the East Coast there are Marakayars and others who have the men and the industry in their hands. However, it is open to Government, as in Ireland and elsewhere, to advance funds or even, as in Japan, to give grants-in-aid either to individuals or to small syndicates of fishermen for the purchase of larger boats, the security being the boats themselves which can be easily and cheaply insured either by Government itself through a very small increase in the annuity of repayment, or externally. As a matter of fact the Ratnagiri men appear to have found means to purchase their boats. This matter will be fully discussed in the final report.

Methods of obviating the fourth difficulty, viz, putrefaction of catches, by deep-sea boats, ice, and live wells.

13. The fourth objection is interesting and weighty; it would be absurd to build boats to keep the sea if the catches are simply to putrefy. Now there are four chief methods of preserving catches from taint--ice or refrigeration (cold storage), live wells or receptacles, daily carriers to and from the fishing fleet, and salt. For the present, refrigeration in the fishing boats may be put

out of the question. Live wells or receptacles, on the contrary, are easy and practicable if the boats are of good size : they were habitual in parts of England as a modern development from the old sorts notably in the Grimsby smacks and in Dutch boats, in which a compartment is built in the middle of the boat by transverse bulkheads, and the sides of the compartment pierced so that the sea freely courses through it ; in this well cod and other large fish are kept alive for weeks and even transferred, at the end of the voyage, to floating chests in the harbour where the fish live till wanted. Ice and steam in 100-ton boats have now mostly driven these smacks out of use. Boats could readily be built on these coasts with such receptacles ; it is possible also to keep fish alive for some days in mere chests of sea-water, frequently renewed by hand. The practice is not wholly unknown since the Minicoy islanders keep live bait in vast quantities in large fine-meshed receptacles in their lagoons. It might even be possible to keep fish alive for a time in coir-rope bags or strong nets outside the boats if wooden receptacles are too cumbrous. But with fair-sized boats live wells are readily possible.

The carrier method of obviating putrefaction of catches.

14. The carrier is a swift boat, steam or motor, which visits the fishing fleet daily and takes away the catches ; preferably it should be provided with enough ice to keep its cargo fresh for a few hours : ice, it is said, can be made even in tropical India at Rs. 14 to Rs. 20 per ton by the Linde machines. A 10-knot carrier can visit even an extended line of fishing boats in a few hours daily, so that catches, recent or kept alive in wells, could be brought fresh to shore ; catches salted at sea on the boats could also be brought by the carrier. But the carrier is a product of organized capital and enterprise, and is used in conjunction with an organized fleet of boats belonging to a syndicate or large owner ; hence for the present its consideration is premature, though the French sardine canner at Mahé is investing in a patrol boat obviously for some such purpose. When capital takes to the industry the carrier will be a necessary item and will materially help to make the seakeeping boat possible.

15. The question of salt and salting or salt packing in barrels at sea is, however, an immediate and practical one ; big boats and cheap salt are intimately connected : as Major Alcock (" A Naturalist in the Indian Seas") says of the fishing near Puri, and as Dr. Day said many years before him, if the Salt rules can be modified great results will follow. The West Coast fishermen cheerfully and voluntarily acknowledges the great benefit of cheap salt in the curing yards and the effect it has had not only on the curing but on the catching of fish by the increase caused in the demand for good dried fish. But cheap salt cannot under present rules be issued to boats proceeding to sea, and while, on the one hand, it would, at present, be useless to issue such salt (except to Ratnagiri boats) since the boats are too small to remain at sea, on the other hand, since it is obvious that even the biggest boats, if without wells, could not, for want of such salt, keep their catches from putrefying, the inability to get cheap salt for use at sea is a reason militating against the building of big boats: conversely and perhaps more correctly, a rule granting the issue of cheap salt would directly, tend towards the building of large boats or would, at least, remove what is now a valid objection. It is suggested that there be made in the Salt Department a rule granting the privilege of cheap salt to boats proceeding to sea, under such conditions as to size of boats, duration of voyage, the due accounting for the issues, etc , as may be found necessary. Probably the Salt Department could frame a rule that salt might be issued in moderate quantities to respectable boat-owners ; the minimum amount of salt required for a given weight of fresh fish is now fairly well known, viz., 1 to 5, 6, 7 or 8 according to the size of the fish, the weather method of salting, etc., and the fishermen would have to account to the curing yard officers, who would issue the salt and inspect and weigh the takes, for the amount issued ; so much salt issued, so much salted fish, balance of salt so much. The risk to the revenue appears slight, especially in comparison with the probable benefit to the industry ; the fishermen will not, in general, run the risk of spoiling their whole catches, of being prosecuted, and of losing the privilege, for the sake of concealing and selling

The possibility of permitting large boats to take cheap salt to sea.

a little salt short-used upon the fish. As elsewhere pointed out, in places such as Tellicherry many boats are controlled by one or two well-to-do traders or curers, and much of the industry is in the hands of respectable persons: these men would not run the risk of petty smuggling and would doubtless be ready to deposit security against unaccounted-for salt.

It is true that the rule would not at first work much benefit except, indeed, to the Ratnagiri boats: except those boats there are no existing craft which could utilize this rule, and it is not asserted that large boats will be built solely by reason of such privilege. But the existence of such a rule would remove one serious objection, and would form one direct incentive to the building and use of deep-sea boats: the rule must precede the boats, for boats would not be built on the mere chance of the privilege being thereafter granted, while, on the other hand, the existence of such privilege would turn men's thoughts to the use of bigger craft. Moreover the grant of this privilege will certainly attract the Ratnagiri boats in larger numbers, which will force the local men to follow suit.

Numerical weakness of boats and population.

16. Then the boats are not only small but they are not numerous. The actual number is not yet ascertained, but except at a few busy centres they are comparatively few as seen on the beach or when with them out at sea: during a day-light sea journey between 10 A.M. and 6 P.M. from Mangalore to Cannanore, always within 5 or 6 miles of land, only one small lot of boats was seen many, of course, go out at night and return in the forenoon, but day fishing is equally general especially during the period of moonlight nights as at the time of the voyage. In fact the fishing population itself is so feeble in number that the exploitation is necessarily weak. The census of 1901, s.v. "occupations" gives for Malabar and South Canara only 109,760 persons under the heads of fishermen, fish-curers and fish-dealers, and this includes not only 63,320 non-working dependants of both sexes but all persons employed on inland fisheries. Hence only 46,440 are engaged in the above three branches of the business, and of these only 23,545 (21,590 males and 1,955 females) are entered as actual workers in fish-catching and fish-curing. After deducting those

engaged in curing it is not possible to put down more than 20,000 persons (men and boys) as engaged in the actual catching of fish (the actual fishermen are seldom curers), and as the average crew of a canoe is perhaps 4 (2 for small and 6 to 8 for large ones), there cannot be more and there are probably less than 5,000 canoes on these coasts, to which must be added one or two hundred Bombay boats for about three months in the year. Hence, in round figures, there is only about one boat (canoe) per square sea-mile within the 30-fathom limit and only one per 3 square miles within the 100-fathom limit.

Weak efficiency of boats and crews.

17. Again, while the number of boats and men engaged in fishing is comparatively small and the boats weak, the efficiency, compared with the apparent abundance of fish, is also small since everything is done by manual labour with small nets easily avoided by fish, and since much of the labour is fruitlessly expended in rowing to and from the fishing grounds. A pair of boats with total crews of 14 men is required to work a very moderate sized dip-net (odam) which averages very moderate takes. Now the crew of a modern British steam trawler with its gigantic net sweeping the sea, or a steam drifter with a fleet of nets miles in length, has but 11 or 12 men including the engine room hands, and there can be no comparison in the respective catching power of these boats. Hence the number of boats and men is no gauge of efficiency in catching when compared with other countries.

Probably abundance or otherwise of fish in West Coast waters.

18. It will be objected that the use of large deep-sea boats and the expenditure of capital and enterprise thereon presupposes that the sea contains fish in quantities which would be remunerative to such enterprise, and that as yet little is known as to the abundance or otherwise of fish life in the deeper waters between, say, 10 and 100 fathoms. The objection is reasonable, but though proof is slight probabilities are strong ; the fishermen express no doubt on the matter ; the boats which go a few miles out, e.g., the Ratnagiri boats, get large catches of good fish ; the inshore catches of deep-sea fish are considerable which presupposes abundance of such fish in the deeper waters, available to

more powerful appliances; tropical seas in general abound in marine life and the many thousands of square miles within the 100-fathom limit on the West Coast, appear to be no exception; the numerous rivers bring down annually large quantities of food suitable for fish life; the varieties of fish are very numerous, and the waters swarm with predaceous tribes which argue abundance of other fauna: large shoals are seen out at sea at periods when they are deficient inshore; the catches of fish even with the primitive appliances available are larger per fisherman than those on the Irish Coast with better boats and gear. It is true that some Western scientists (see Johnstone's "British Fisheries" 1905, page 196) declare or consider that plankton or fish food is *less* abundant in tropical waters owing to the greater prevalence of denitrifying bacteria, and if such fish food is less abundant it is probable that fish may also be less. But the suggestion is theoretical and there are no actual data at all events for Indian waters: the probabilities seem the other way. Indian capital, however, is remarkably shy of investment in probabilities, and the matter of quantitative experiment and proof by trawling, etc., as well as of experiments in salting at sea and of more rapid and better transport to and curing on shore, will be placed separately before Government if Government signify that they are prepared to undertake considerable expense in such experiments, e.g., in fitting the "Margarita" (probably not very suitable) with a trawl, in engaging an expert trawler, curer, and so forth.

Amount of catches estimated and compared.

19. The actual catches of the West Coast are not known, but on an average of five years ending 1903, 40,000 tons of fish were brought to the curing yards of that coast, in which, however, are included the heavy catches of the comparatively large Ratnagiri boats from the Bombay Presidency. There is considerable local trade in fresh fish within a 10 or 12 mile limit from the shore; the fishermen's families are also provided from the catches, and in most years a good deal of small fish (sardines, prawns, etc.) is simply dried on the beach without going to the yards. The fresh fish trade does not absorb so much fish as might be supposed: 11,000 tons will give 100 lb. per annum

to each man, woman and child of a quarter million people which is probably the outside *daily* number served with fresh fish on this coast. Assuming the total catches as 60,000 tons, each boat catches 12 tons per annum or about 1 cwt. per working day taken as 240 for the year after allowing for holidays, monsoon and adverse weather, and other obstacles to fishing. If the area within 30 fathoms from somewhat south of Cochin to somewhat north of Coondapoor be taken as 4,800 square miles of 825 acres or, say, 4,000,000 acres, then the catches amount to 1 ton per 66 acres or 34 lb. per acre; if the area, easily fishable, within 100 fathoms be considered, then the catches average 1 ton per 200 acres or 11 lb. per acre per annum. These catches are small in the aggregate, but it is to be noted that the average amount of fish landed on the Irish Coast in the three years 1902, 1903 and 1904 was 39,000 tons exclusive of a moderate amount of shell-fish; this was caught by about 21,000 men and boys (about 600 of the latter) in Irish boats *plus* those in English and Scotch boats who may have landed their catches on the Irish Coast. Hence the average catch per fisherman in Irish waters was below 2 tons, although at least half the Irish boats and gear were much superior to Malabar boats, and a dozen steam trawlers and many decked smacks are amongst the Irish fleet. But on our West Coast 20,000 men and boys caught 60,000 tons, *i.e.*, 3 tons apiece and considering the primitive nature of the apparatus used, the entire absence of powerful vessels, machinery and nets, and the fact that all boats and gear are worked solely by manual labour not very effectively applied, this quantitative result shows that the local waters abound in catchable fish. Moreover, however imperfect the figures tentatively adopted may be, it seems clear that the labour of one man on the sea is more productive than the same labour on shore; each fisherman produces by his labour, with the addition of boats and gear which cost very moderate amounts annually per fisherman, about 3 tons of highly valuable food: on an average of years a man's labour on the soil of this Presidency with the aid of cattle, ploughs, manures, etc., does not produce any such equivalent of food except, perhaps, under very favourable circumstances. It is clear, then, that since fish are so abundant

as to yield, even to primitive methods, catches large in comparison with those of Irish fishing and yet small compared with the catches (10 tons per head) of English and Scotch boats and with the estimates of marine productivity per acre made by commissions such as that of 1863, there is a strong probability of very much larger catches with better means and organization. Hence the desideratum now is more men and more efficiently employed labour and better apparatus in view to much greater returns and a still larger utilization of the harvests of the sea.*

General weakness of exploitation of the Presidency seas.

20. The weakness of the exploitation of the sea for the Presidency generally, on both coasts, may here be adverted to. It is generally understood that marine fishing on the West Coast is far more active and productive than on the East Coast, a belief founded partly on the small quantities brought to the curing yards of the East Coast, partly on the small size of the boats (usually catamarans) there employed, partly on observation; the 30 and 100 fathom limits are also far narrower than on the West Coast. The total sea-coast line (*exclusive* of sinuosities and indentations) is 1,600 geographical miles inclusive of Travancore and Cochin, or 1,420 exclusive: by the census of 1901, there were 402,353 persons (or not much above 1 per cent. of the total population) interested in fishing, curing, or dealing, of whom, however, 204,126 were non-working dependants, leaving 198,227 workers; this includes all inland and estuarine fishermen, persons partly agriculturists, and all those classed as fish-dealers very many of whom are the wives of the fishermen who hawk the fish in the streets and villages, the numerous petty fish sellers, and the runners who take the fresh fish inland. Out of these 198,227 no less than 46,440 or nearly one-fourth are found in the two districts of Malabar and South Canara with a sea frontage of only 240 miles out of 1,420 or one-sixth. But this one-fourth provides three-fourths of the whole amount of fish brought to the fish-curing yards of the Presidency, of which there are 47 on the West Coast as against 89 on the East, or,

* Later investigations show that, including the vast quantities of sardines which are beach-dried for manure, the weight of fish taken in a good year on the West Coast is far larger than is suggested in this paragraph.

conversely, three-fourths of the fishing trade deal with only one-fourth of the fish. Hence, unless there is a relatively enormous fresh fish trade on the East Coast, which is unlikely except at Madras and a few large centres, the exploitation of the sea on the East Coast is trivial and the amount per head insignificant as compared with West Coast catches. More especially is this the case when compared with the Japanese fishing population, which is said to number over 900,000 families or 11 per cent. of the 8,182,000 households in the Empire, though, of course, the coast line is very much longer in Japan. This point will be closely examined in the East Coast tour about to begin. The above remarks are, at present, wholly in the rough and susceptible of large correction in detail, though probably correct in the main; the final report will deal more exactly with this very important point.

Character of curing operations.

21. Again, curing operations are both primitive, undiversified, and slow yet incomplete. Sun-drying, with or without salt, is, with small and occasional exceptions, the only curing method found; fish are gutted, rough-salted in troughs for a night, washed (sometimes) in sea-water, and then exposed on the open sand to the direct rays of the sun for two or three days till fairly dry; such is the simple and regular process. If the fish have been brought to the curing-yard fresh and wholly untainted, if enough salt has been used sufficiently promptly, if the subsequent washing has been effective and the sun bright, the resulting product is fair though probably unacceptable in appearance and odour to western markets. But if the fish when brought in is, as is often the case, by no means fresh or free from taint, if the salting is insufficient or not thoroughly penetrative of the tissues, if, as is often the case, the subsequent washing in fresh sea-water is dispensed with, if the drying yard is shady or the drying process slow, then the resulting product is distinctly unpleasant and probably unwholesome; maggots are not uncommon, the putrefactive odour strong, colour and appearance poor and even repulsive. In many cases, moreover, the smaller classes of fish are simply sun-dried on the beach without salt and with or without gutting; these are very malodorous and more fit for manure than for food

though they are sent inland, e.g., from Tanur, for food. It is said, in South Canara, that the locally salted and dried fish does not keep well during the monsoon but gets soft and unpleasant, so that considerable quantities of dried fish from the Persian Gulf which keeps better are imported; the reason for this difference is not at present known.

Exceptional methods of curing.

22. The exceptions to the above method are at present trivial; one is the method practised by Ratnagiri men at Malpé for treating large fish. A second is the preparation of so-called "tamarind fish" at Cochin for the Colombo market; this method resembles that of pickling herring "wet" in barrels, viz., the placing of the fish (mackerel as a rule) in alternate layers with salt in hogsheads of 60 to 65 gallons capacity which are locally and well made: a small quantity of "guraka (or 'kudum') puli" (Malabar tamarind) which gives the name to the product, is added, and the barrel after settling for a few days is then partially drained through a spigot hole, filled to the top from a barrel of similar age, and the whole headed up. This product must not be confounded with the "tamarind-fish" (pada) known to Europeans, and also prepared on the West Coast: this is a mere domestic product and consists of seer preserved in various condiments in jars. A third exception is the enterprise of a French resident at Mahé who tins sardines: this manufacturer keeps his processes jealously secret, but is apparently succeeding since he has applied for a petrol or alcohol license in order to use a motor boat in his industry: at present he is the solitary canner on the Coast, and his products are, as compared with those of Europe, remarkably cheap: merchants of other places are anxious to ascertain the processes of canning which I have explained to them: full details will be found in my final reports.*

These exceptions, then, are of little importance, and there is a singular lack of all processes and of all knowledge of processes other than the common method; smoking, pickling wet in salt, canning, mealing with or without subsequent compression, and so forth, are

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* A Government cannery is now (1914) in successful operation.

practically unknown, though most of them could be readily carried out without expensive plant, and a food product, superior in quality, wholesomeness, and keeping power, could be distributed widely throughout this and other countries.

Detailed account of present curing methods.

23. An account of the curing process will display its weak points and indicate the openings for improvements.* The fish belonging to each curer are gutted (and, unless sardines or mackerel, split, and scored with deep cuts if the flesh is thick) with fair rapidity but with little or often no shelter from the sun, which is usually high. The gutted fish are then placed in baskets, washed in the sea, and conveyed to the curing yard; frequently the baskets are delayed until a considerable consignment is ready for entry. The baskets are then weighed and passed in with the order for salt in the proportion usually of 1 to 7 for large and 1 to 8 for small fish; after the salt has been issued out of store the fish are taken to the curer's shed and placed in a trough which is usually a small canoe or of that shape: a rough layer of the fish is then laid in the bottom of the canoe and sprinkled with its modicum of salt followed by successive layers and portions of salt till the whole is used up; the salt is in coarse crystals and not in powder. This may take place any time in the day, but usually at or after noon as the boats seldom come to shore before 10 A.M. Assuming it to be Monday afternoon, the fish remain in the salting trough till about 8 A.M. on Tuesday when they are taken out for drying; in the best yards they are then washed in clean sea-water from the dirty brine and foul matter adhering to them, but this is not generally done on the West Coast. The fish are then placed in the open sun, either on the sand or on mats, and left till sunset when they are gathered up and covered with mats; on Wednesday morning they are again spread out in the sun and, if small fish, are sent out of the yard in the afternoon; if large, they are again heaped for the night, further dried on Thursday and issued on that afternoon; it is usual to expose fish intended for export, to further drying for

* The excessive exposure, careless treatment, and undue handling which the fish undergo from the moment of capture till they reach the gutter, should also have been mentioned.

several days outside the yard. On the average, fish which weigh 50 lb. fresh, weigh 30 lb. when sent out of the yard, i.e., their weight is diminished by 40 per cent.; small fish show a somewhat larger and large fish somewhat smaller dryage.

Faults noticeable in curing processes.

24. It will be seen that there are several radical faults in the process. In the first place, the fish should as far as possible be sheltered from the sun especially in the gutting process before transmission to the yard; at present this is but slightly the case. Secondly, transmission to the salting shed should be rapid whereas it is often dilatory; sometimes the delay is due to an attempt to sell it first as fresh fish; sometimes it has to wait the making up of the fisherman's consignment; I have seen it waiting for hours in heaps and baskets. Thirdly, the salting is imperfect; the amount used ($12\frac{1}{2}$ to 14 per cent.) is small as compared with that used in countries which are colder and in more advanced processes such as the "tamarind-fish" of Cochin or the Ratnagiri method at Malpé; the salt being in coarse crystals instead of powder cannot be thoroughly rubbed into the tissues and penetrates slowly; the shape of the canoe permits the brine to drain away from the fish unless, which seldom happens, the canoe is full of fish, so that the top layers, at all events do not soak in brine but are left comparatively dry and therefore more open to putrefaction; only the bottom layers are well off being better protected from the air, while by the weight of the upper layers the salt is forced into the tissues and the strong brine floating at the bottom of the canoe soaks into them; the duration of salting, from 12 to 20 hours at the utmost, is insufficient for the salt thoroughly to penetrate the flesh especially when the fish is thick and firm and the salt very coarse and the entry into the yard late. Fourthly, the fish when taken out of the brine is foul with various matters and washing is very necessary; this is frequently omitted from sheer disinclination to take the trouble to fetch the sea-water; the dried product is consequently dirty and discoloured while the foul matter tends to more ready decomposition. Fifthly, drying is slow, discontinuous and imperfect so that the putrefactive process is continuous almost throughout. The danger and even progress of

putrefaction does not cease till the fish is stone-dry; hence, in a tropical climate where decomposition is extremely rapid and persistent, desiccation should be as rapid, continuous, and complete as possible. Now, as at present conducted, it is not rapid; the sun may be powerful but its effect is discounted by the atmosphere which is always moist to some and often to a large degree; the fiercer heat only obtains between, say, 10 A.M. and 4 P.M., and is moderate during the other hours of daylight; at best, the temperature of the rays, say, from 100° to 145° F. according to the season and the time of the day, is insufficient to rapidly dry a very watery article such as fish direct and undrained from the salting trough. Moreover the heat is seriously discontinuous, since from 6 P.M. to 7 or 8 A.M., the sun is not available; consequently, since the putrefactive process continues so long as the fish is moist (for the salt at best merely delays putrefaction when once the fish is removed from the salting trough) this process continues during the first day, proceeds during the long night, and is only stopped when the article is thoroughly dry, i.e., not till the end of the second or third day of drying. In fact, since fish contains from 75 to 80 per cent. by weight of water in its tissues and has lost only 40 per cent. on leaving the yard, it is clear that the putrefactive process must have been acting, though perhaps slightly, throughout the curing operations, and must continue subsequently if no further precautions are taken; probably no amount of mere sun-drying affords such desiccation as is a complete precaution in the tropics.

Improvements suggested or possible.

25. In my final reports * existing methods will be detailed which enable salting to be carried out more quickly and effectively and subsequent desiccation more thoroughly but there is no reason why the present practice should not, at an early date, be quickened as well as varied. The drying grounds might be made more effective if formed into barbecues and it would not be difficult to combine solar and artificial heat so that drying might be not only more rapid but even, and continuous through the night. The several smoking processes not only smoke and flavour, but rapidly dry and preserve fish,

* Bulletin III (Preservation and cure of fish) deals more fully with fish curing; a revised edition is now (1915) under preparation.

wood smoke, containing creasote, etc., being considerably anticeptic ; the critical stage, in fact, is practically passed, at least temporarily, as soon as the fish is fairly in the smoke kiln ; for such smoking, paddy husk and various woods are fairly cheap and abundant, and on the sandy shores casuarina (and other fuel timbers) can be readily grown, as at Mangalore for the pottery kilns and other purposes. The wet process in which the fish is kept continuously in salt in closed barrels until consumed, at once removes the fish from danger for a time sufficient to permit of transport and leisurely sale : indeed the "tamarind-fish" is said to keep good for many months if not indefinitely. As for canning, which the French manufacturer has begun, danger of putrefaction ceases from the moment the fish are placed in the boiling oil or under steam or in the chloride of calcium bath. The method of reduction of the fish to meal with rapid artificial desiccation and with or without subsequent compression into hard cakes, may be too expensive and elaborate for present adoption, but cod-fish meal is a regular item on the American market and dried fish, powdered and compressed, formed, it is believed, the basis of the Japanese war ration.

Catching and curing alike need modernishing.

26. Just as the catching process is primitive, insufficiently effective, restricted in area, and slow in communications, so the subsequent curing process which, in a tropical country of vast distances and in the absence of rapid internal communications refrigeration, and organisation, must supply the inland trade, is primitive, slow, ineffective and undiversified, and it should be modernised and improved by the aid of science, knowledge and capital, if the product is to be thoroughly wholesome and widely marketable. Even in non-tropical countries and regions every effect that can be devised is made to secure rapidity, the culmination perhaps being reached in the canning factories of British Columbia where 20 minutes suffice to pass salmon from the wharf through the cleaning, cutting up, and tinning rooms to the steam bath.

Complaints by curers—(1) The 10 P.M. rule.

27. Among the complaints made by curers are several which bear materially on the curing of fish. The first is the rule that no fish can be brought into the yard

after 10 P.M. It not infrequently happens that shoals appear suddenly and continue within catching distance for many hours; in such cases, if the rule is strictly observed, it is useless to catch fish much after sun-set since they cannot be cleaned and brought to the yard before 10 P.M.; consequently, the fishermen lose opportunities of large profits. Several cases were mentioned to me in which the rule worked hardship, one very serious instance, in 1904, being a case where it is said that fish worth Rs. 8,000 were brought to the yard after 10 P.M. and being refused were irretrievably lost. Such cases may not be common but are both possible and, from the manner in which shoals of sardines and mackerel appear, probable; and it is reported that one chief source or cause of "māmūls" (bribes, presents, or illegal gains) is the necessity of getting valuable catches into the yard after regulation hours. It may not be possible, even at the largest yards, to provide duplicate establishments during the shoaling seasons, but several curers expressed their willingness to pay "overtime" on necessary occasions. A rule which would make the hard-and-fast 10 P.M. rule more elastic and legitimize payments for overtime, would *ipso facto* do away with this source of "māmūls."

(2) Inability to wash fish in the sea after salting.

28. Another complaint was that the curers were not allowed to take the fish from the salting trough to the sea for the purpose of cleaning it from the foul brine and matter which cover it; at Tellicherry the curers employed labour to bring sea water to the yard, but the washing thus effected is not nearly so thorough as when the fish are taken in baskets and swung for a few moments in the open sea. In many other yards the process of washing is wholly omitted although, as pointed out by the Tellicherry people, the absence of washing makes a difference of perhaps 10 per cent. in the value of the product. The curers ask for some rule by which they would be permitted to carry the fish to the sea, usually not many yards distant, and wash it there.

(3) Dearness of curing-yard salt in Malabar as compared with South Canara.

29. A third complaint is in Malabar only, viz., that the salt is sold to them at the rate of Re. 1 per maund and for not less than one anna ($2\frac{1}{2}$ seers) at a time, whereas their neighbours in South

Canara get it at As. 6–8 per maund and can buy even a single seer at the price of two pies. To take one instance of the result of this difference; if a man in South Canara has 32 seers of mackerel which require four seers of salt (at the usual rate of 1 to 8), he obtains exactly those four seers at a cost of eight pies; if however a Malabar man has the same quantity of fish he must buy at least five seers at a cost of two annas and he is then tempted to smuggle the surplus seer. This difference in price acts as a considerable handicap upon the Malabar curer and the rule might, I consider, be modified. The history of the As. 6–8 rate in South Canara is given by Dr. Thurston in his Bulletin, but I am not aware that any pledge has been given that this rate should not be raised, and it would seem more equitable if the rates were equalised in both districts, as for instance, by making the price As. 10 per maund, *i.e.*, one seer for three pies.

Suggested general use of gauged baskets.

30. One source of delay, especially when delay is most to be avoided, viz., on the occasion of heavy catches of sardines and mackerel (the latter a notoriously putrescible fish), can be lessened by the general adoption of gauged (1 or 1½ maund) baskets. When such baskets are not used every consignment has to be weighed on entry into the yard since the baskets are irregular in size and the salt required therefore varies; this causes delay to the curers and trouble to the yard officer; if, however, each basket was so made as to hold just 1 or 1½ maunds of small fish they could be passed rapidly into the yard by mere counting. Not only so but the fishermen themselves would then sell their catches to the curers by baskets instead of by count; at Tanur these baskets are actually (very recently) in use, and sitting on the beach I noticed that the sales to the curers were made simply by the basket; there was neither counting nor weighing so that much time and handling at a critical period were saved. Probably baskets are only useful for small fish, but these are just the shoaling fishes which cause rushes at the yards.

Necessity for yet lack of rapidity of operation in tropical climate.

31. The time element, or the speed with which fish can be secured against taint, in the tropics, while one of the most important is, at the same time, one

of the most difficult to deal with. Here where the great heat demands extreme rapidity we are confronted and baffled at once by the slowness of every kind of operation from catching to curing, and by the absence or prohibitive dearness of all sorts of preservatives and preservative processes, such as, live wells or chests, salt, refrigeration, etc. The large fishing boat with well, salt, ice or cold storage, the speedy steam or motor carrier from the fishing boats to shore, the rapidity of manipulation, transport, etc., on shore, necessary even in a temperate climate or cold weather, are precisely the aids which are lacking in this tropical and backward country, yet are essential, at least in some degree, if the industry is to be developed as a great source of food and wealth. There are, on the West Coast, just the germs of some such development, the comparatively large Ratnagiri boats buy a little bazaar salt and partly cure their catches at sea, small canoe carriers belonging to dealers, go out, buy from the fishermen at sea and bring to shore, the canning of sardines has at least begun, and merchants have enquired as to methods and possibilities both as regards canning and other curing processes. But there are no signs of organised, clear-sighted, resourceful effort on modern lines; power is not employed; speed is hardly thought of, cheap salt as supplied to the curing yards is not available in the boats for the instant commencement of curing; refrigeration is undreamed of though not impossible, at least on shore, since ice can be made even in the tropics, at from Rs. 15 to Rs. 20 per ton according to the size of the machine; live wells are not attempted, the boats being small, though even in the Minicoys fish fry, intended for live bait, are abundantly stored, till wanted, in fine-meshed receptacles of large size moored in the lagoons. Improvement, however, needs knowledge, enterprise, capital. *Knowledge*, first, and of this there is at present almost a total lack; no process save the ancient method of sun-drying seems even to be dreamed of. *Enterprise* next, and this seems lacking in the development of the fishing industry as an organised business, from the obtaining of the raw material to the finishing of a superior product, though abundant enterprise in other lines is shown on the West Coast by European, Hindu, Mahomedan and Jew. *Capital*, and

this is certainly available in several centres both on the West and East Coasts, but is not applied for lack perhaps of knowledge. It is hoped that at least one result of this investigation will be to stimulate and facilitate new and more rapid processes, not only by supplying in my final reports full working details of apparatus and processes from the fishing boat to the marketing of the goods, together with estimates of cost, but by indicating the places where the knowledge and plant necessary can be obtained or bought by practical men.

Fitness of West Coast waters for modern developments.

32. So far as I have been able to see, the coast in general, save for slight exceptions, is admirably adapted physically for modern developments. The bottom appears to slope gradually to the 30-fathom limit, thence more steeply too 10 fathoms, after which there is a precipitous fall. But within this 100-fathom limit, which may also be taken as the trawling limit, there are perhaps 17,000 square miles in a strip of sea averaging perhaps 40 miles in breadth, nearly the whole of which has a smooth, undulating bottom, usually of sand, mud, or ooze ; there seems little to hinder a trawling net especially of the otter pattern. The weather again is far better than in British waters ; for 8 months, October to May, there is seldom anything but fine weather ; the general direction and force of the wind are known, and it is possible for months together to count with certainty on good weather and on particular winds ; for months together boats may go regularly to sea in the early morning with a strong landbreeze and return in the afternoon with the seabreeze without fear of either calm or storm. It is this regularity and certainty of weather which contracts so strongly and so favourably with the uncertainties, with the bewildering, violent, and dangerous changes of British or other Western weather, while the climate is, so far as the workers are concerned, far more favourable than that of the winter in the North Sea or on the New-foundland bank or even in British waters ; even the sea is generally calm as contrasted with the Atlantic, the Bay of Biscay, the Adriatic, or the North Sea. Without the above advantages, indeed, it would be impossible to risk even short deep-sea voyages in the crank canoes which are practically the only boats in use. Hence for fishing other

than trawling, boats ordinarily sea-worthy could readily venture and stay out far beyond the 100-fathom limit to which the trawlers would be restricted. Even in the south-west monsoon there are many weeks in which fishing is not only possible but practised, especially where mudbanks are found as near Cochin, and though waves may at such times be high yet the weather is seldom stormy. As regards ports and harbours, the coast is not well provided for really large craft, since where harbours or backwaters exist there is usually a shallow bar; but during the fair season, large fishing smacks could, like the coasting boats (pattamars), lie out in the open with perfect safety, while in the monsoon such boats would lie up in harbours such as Cochin, Mangalore, etc., venturing out whenever the sea is practicable; where there are mudbanks there is less difficulty. On the whole, I consider, that these West Coast waters are admirably adapted physically for the development of fishing.

Apparent and regrettable absence of seaweed.

33. One circumstance indeed seems unfortunate; the shore and bottom of sand, mud, etc., appear to casual inspection singularly devoid of vegetable growth so important biologically, as shelters and sources of fish food, as well as economically; so far as I have seen, there is, speaking generally and in the absence of submarine investigation by dredging, etc., no such valuable growths in these seas except in the comparatively restricted area of reefs and rocks. In Japan the seaweed industry, besides its vast biological importance, yields products worth some 60 lakhs per annum exclusive of the large amount consumed by the 900,000 families of fishermen; food, vegetable isinglass, iodine, manure are largely obtained from Japanese algæ. The subject is of such importance that it will be closely examined hereafter.

Close season afforded by south west monsoon

34. Again, while the south-west monsoon does not wholly stop fishing, it forms practically a close season of four months during which fish are but slightly disturbed by man. The importance of this is obvious; for instance, the sardine and mackerel—the great shoaling fishes of the West Coast—spawn in June and July, i.e., at the beginning of the monsoon; according to the fishermen

men they are full of ripe roe and milt in those months, are found empty in succeeding months, and have grown fat by the time the shoals appear in November. Hence, so far as man is concerned, fish and their young are but slightly disturbed during several very important months.

Ravages of abundant predaceous fish.

35. But the great enemies of fish in these seas are not man but the variety and enormous number of predaceous fish; to take but one instance, the number of sharks of all sizes from 18 inches up to a recently recorded monster of 28 feet is incredible and their appetite insatiable; with them breeding seems continuous, and with from 4 to 8 at a birth the breed is necessarily vastly numerous; few catches are devoid of sharks of small size, and larger ones are commonly taken. The predatory efforts of man are at present puny besides the ravages of this tribe alone; fortunately they are of considerable food and industrial value as the flesh is largely dried and eaten, while the dried fins are exported to the Straits and China in large quantities, the value being in the case of the best "white" fins as much as Rs. 30 to 40 per maund of 30 lbs. It may be found necessary to wage special war against these predatory tribes just as in the West it is now being found necessary to wage war against the destructive dog-fishes of those waters.

Possibility of transplanting the hilsa to West Coast waters.

36. It is curious that while the hilsa (*Clupea ilisha*) is found abundantly on the East Coast from Tanjore to Calcutta and continues to attempt the ascent of the Madras rivers notwithstanding the barriers of the anicuts, it is not even known on the West Coast where there are numerous rivers absolutely open to their ascent and probably better supplied with water; on the other hand, the sardines (*Clupea longiceps* and *Clupea fimbriata*) though so abundant on the West Coast do not seem to shoal so largely on the East Coast though they appear in some quantity and seasonal regularity on the coasts of Vizagapatam and Ganjam districts. It will be an interesting problem in pisciculture whether the hilsa can be successfully transplanted to the West Coast,* as the shad (*Clupea sapidissima*) and the bass were transferred

* One attempt has been made with slight success by Mr. H. C. Wilson, Piscicultural expert in the Fisheries Department; other attempts will shortly follow.

from the Atlantic to the Pacific ; it is believed that hilsa once hatched in a river return there or to the neighbourhood to spawn, so that successful transplantation to one or two rivers might populate all of them and the neighbouring sea, as the transplanted shad and bass have populated the Pacific coast.

Capital and labour: instances of their relation with results.

37. The relations of capital to labour are very various with curious but readily intelligible effects on the industry. In places, e.g., Tellicherry, it may be found that the great bulk of fishermen are under the control of the curers who either own the boats or have control over the owners under the advance system ; the curers may be considerable capitalists, and in one curing yard two persons owned or controlled about two-thirds of the boats. In such cases the fishermen are usually bound to bring direct to the curers the whole of their catches and cannot sell them to others, so that the curers are sure of a continuous supply of fish, large or small according to the chances of the sea ; they do not require to go to the beach and chaffer with the fishermen or compete with other buyers. Here we have capital directly employing labour and the labourers are practically bound to the capitalist. In other places, e.g., Tanur, the contrary may be the case ; here most fishermen own their boats ; they may indeed be somewhat in debt to money-lenders but they are seldom, if ever, under the control of the curers or dealers, and they sell their catches on the beach to the highest bidder ; conversely the curers have no certainty of supply of fish but are obliged to buy in open market ; this independence of the fishermen and this freedom of sale is an attractive feature and consonant with our ideas of independence and the open market. But the results, even on the existing fish trade, of these two systems (there are other systems and relations which will be mentioned in the final report) are remarkable. Tellicherry dried fish is the best on the market ; it is not unpleasant to smell or taste, it bears a good price, and is exported in immense quantities to Ceylon where bad fish is refused ; Tanur dried fish is malodorous and poor in quality and goes wholly to inland markets. One cause appears on enquiry ; at Tellicherry and the neighbourhood the fish is not detained on the blazing beach while the fishermen are

waiting for the highest bids ; it goes direct to the curers and to the curing yard; in Tanur, on the other hand, there is, to my own knowledge, frequently considerable delay caused by the usual and lengthy higgling which, at high noon, adds to any existing suspicion of taint ; fish once tainted, of course retains the taint and the product is of low quality and, probably as unwholesome as it is malodorous ; anyhow, it is not found good enough for Ceylon but only for dumping in our own villages. Moreover when prices asked are too high, curers frequently decline to buy at all, so that the fishermen have to do the best they can with their catches, and large quantities are simply dried on the beach. Again, at Tellicherry all fish is dried for either two or three days in the curing yard and is then dried privately for several days more outside ; the curers being men of substance and able to lock up part of their capital, for some days or weeks, produce a thoroughly cured and dried article which bears a good price and finds a good foreign market. In Tanur the very first "grievance" stated by the curers was that the retention in the yards is unduly long, and curers wanted the fish to be issued in one or at most two days. Now the reason for this extraordinary request is based upon the necessities of the independent system ; the curers being small men of no capital are obliged, in order to buy further supplies of fresh fish, to recoup themselves in funds by selling their "cured" goods as soon as possible, while by selling them half-dried they think they obtain an advantage in weight since the goods are still damp ; consequently these hastily cured and badly dried goods are sold off with all speed to the inland traders. It will be seen then that the independence of the small owner at Tanur is not necessarily to the benefit either of the fishermen or of the curers or of the industry ; the curers not being sure of a continuous supply of fish will not put capital into the business ; the result of want of capital and of petty business is an inferior article of food and trade ; and not only does such inferior article fetch a small price and return smaller profits both to curers and fishermen, but the demand for fish is curtailed and the fishermen's business is cramped. Perhaps the fishermen come off best at Tanur being independent, but the industry and therefore the general public suffer.

These interesting and important questions will be more fully investigated and reported on.

Probable development of West Coast fishing industry, viz., from the independent fisherman and small boat to the capitalist and labourer.

38. But when the development of fisheries elsewhere is viewed historically and its economic conditions considered carefully, it is seen that progress has been and, in the present form of civilisation, must be, from the independent fisherman with a single small boat and petty local trade to the capitalist-employer with his fleet of large boats and his wages-paid crews ; and it will be so in this country, the more so that the actual sea-faring fishing population is, in India, born and not made ; if not a caste, it carries on a business into which only certain castes or races will enter, and it will *by itself* never provide the essentials of development, namely, knowledge, enterprise and capital. These people are all poor, ignorant and personally wanting both in the capital and in the business capacity and initiative necessary for a real exploitation of the harvest of the sea ; the boats, gear, curing houses, trade organisation necessary to give proper efficiency to the men and development to the industry, can only be provided by large capital and business brains ; if the seas are to be worked properly, if cheap and good food and manure are to be distributed over the country, then large, well-found boats possibly aided by power, modern gear, swift carriers, cheap preservatives, clean, rapid and varying curing processes, concentration and economical methods, utilisation of by-products, carefully arranged transport, organised business ramifications, must take the place of the present primitive haphazard methods ; the independent boatman with his catamaran or canoe, the petty individual curer with his pinch of capital and half a dozen baskets of fish, the small market dealer or buyer, the fresh-fish runner, will, if they do not altogether disappear, take a new and perhaps individually inferior place as the employés of capital. In this country the difficulty or shock of transition will be slight ; the indigenous industry is not that still to be found in England and Scotland where some of the finest men of the kingdom, thrifty, shrewd, fairly educated, hardened in fibre and highly skilled by toil and danger, owning their own somewhat costly smacks and gear, independent

beyond most men both by reason of status and occupation, are rapidly giving way to the Company and the Syndicate. The Madras fisherman, though in a way skilful and fairly hard-working, cannot compare with his British confrere in status, fibre, or position, and any change in his status will scarcely be felt by himself and not at all, except in the way of progress, by the industry or by the country. The process has already begun in Tellicherry and other places, and the coast railway now open to Cannanore, and shortly to reach Mangalore, supplies cheap and rapid communication which is one of the essentials, but hitherto a missing factor, of the organization of the industry; the railways have largely made Grimsby and other great fishing centres with their splendid fleets and organised fishing industry, and the Madras Railway will be the making of the West Coast fishing and curing yards when capital and business enterprise have joined with it *en triplice.*

39. A very great industry is now opening to enterprise. The primary opportunity for such an opening was given by the grant in the fish-curing yards of cheap salt at a cost, including cost of manufacture and carriage, of only As. 6–8 in South Canara, and Re. 1 in Malabar per maund of 82 lb. The opening of these yards and the consequent lifting, in no small degree, of the grave burden of the salt tax, is primarily due to Dr. Day whose report of 1873 insisted on the necessity for providing cheap salt to the curers if both the fishermen who catch and the trade which cures and distributes, were to find a market, and if the public were to be provided with cheap and wholesome food. His proposal that enclosures for curing might be provided in which salt should be supplied at rates just remunerative to Government was accepted, notwithstanding the objections which were imagined, and these enclosures are the present fish-curing yards. I do not think that the debt of the Presidency to Dr. Day for his advocacy of this reform has been fully recognized, though obvious to observers of present activities. If a rule regarding the use of cheap salt in boats, as suggested in paragraph 15 *supra*, can be devised, another step will have been taken towards the development of the whole trade.

To this reform has now been added an improvement in communications such as Dr. Day could hardly have

imagined, and with these and with refrigerative and preservative methods introduced, cheapened and improved by modern science, there is opened up an early possibility of new, wholesome and cheap food supplies for the million and of vast markets for the industry. As was originally said of Novo Scotia forty years ago, fish could be had for a song, and money could have been made in piles by any one with a knowledge of curing, had there been any means of communicating with the great markets of the world. Such an opportunity appears to me to be opening up for the Indian fish trade especially on the West Coast.

By-products ; oils.

40. These are few and of slight industrial importance. Fish oils, for instance, seem practically to have disappeared from the export market though I find it asserted in books that as much as 150,000 cwt. of sardine oils were occasionally exported in a single year from Cochin alone, besides other oils such as "shark" and "Malabar" oils, while the average annual exports of all animal oils from the whole Presidency in the three years ending 1904–1905 was only 7,270 gallons, most of which went to Turkey in Asia. The reason for this disappearance is under enquiry, but it is possible that former enquiries did not sufficiently distinguish between vegetable and fish oils and that the exports of the latter, though considerable, were unintentionally exaggerated. If the former figures were correct it can only be said that a great industry and trade have been lost and should be recovered, since the fish, always irregular in appearance even in those days, are probably just as abundant as then, while better plant and organization should secure more continuous supplies and modern knowledge should manufacture a better article. Probably the malodorous, badly prepared product could not compete with the better class of oils of other countries, while mineral oils are known to have ousted much of it from use; even on the West Coast itself, mineral oil is already mixed with fish oils for caulking and smearing boats, and an agent for thick Rangoon oil has recently been preaching its superiority to the boatmen. The fish oils, as seen, are disgusting in odour and wretched in appearance; the only method which I could find in actual use for the preparation of the shark and sardine oil was the exposure

of the shark liver, or refuse sardines and their offal, to decomposition in pots or vessels; three pots of shark liver yield one pot of oil; the resulting oil is skimmed off, while the decomposed (sardine) "scrap" is used as manure for tobacco and cocoanut trees, and provides a smell which in sickening and penetrative capacity surpasses all that I have known in a wide experience of smells. The business should be worth revival; if oil were properly prepared, not only should it find a good market but the "scrap" will then form a valuable manure especially in conjunction with the offal and bones which are now thrown away and in many places render the shore and sea margin noisome with decaying matter.* On the Bombay and Sind coasts it appears that various classes of very large sharks, saw-fish, and oil-bearing skates are extensively caught for the sake of their oil which, curiously enough, is or was classed in trade as "Malabar" oil; the vast abundance of sharks, though of small size, on the West Coast should prove a great source of fish oil. In passing, it may be noted that no use is made of crocodile oil though the Indian crocodile is said to yield large quantities, and is greatly in evidence as a devourer of fish and otherwise in the West Coast backwaters. Similarly the porpoise is seldom caught, at least intentionally, though very abundant; I saw three only, which had been taken in so flimsy a net as a mackerel net; the porpoise had struck this in their career, entangled themselves at first, and then in a flurry had absolutely tied themselves up in it. The flesh of the porpoise is eaten though not readily, but oil is not extracted and the use and value of the hide are unknown.

Manure.

41. Manure is only prepared, as stated above, in the crudest of ways, and vast quantities of offal (guts and heads) are thrown away; it is difficult to utilize stuff which, though bulking large in the aggregate, is of no great quantity daily, and is spread over a long line of coast; the fishermen not being agriculturists seldom apply it themselves and the ryots do not often go to the trouble of fetching it away. Manure as an article of regular manufacture awaits the

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* The method of boiling the fish, removing the oil by skimming and pressing and the drying of the "scrap" as manure (fish guano) was introduced in 1908 with the result that in 1914 there were 211 small private factories stretched in a chain along the coasts of Malabar and South Canara, in which this improved process is carried out.

concentration of fish in definite centres of large catching and curing business. The sardine manure business is an exception, but is intermittent; when catches are so abundant that they cannot be sold fresh or cured in the yards, they are simply rough-dried on the beach all along the coast and are then sent, if the distance is not too great, to a Calicut firm which further dries and deals with the stuff; there is no continuous regular manufacture from fish refuse, such as offal, "scrap" from which oil has been extracted, fish bones, etc., simply because there is and at present can be no concentration of catching and curing. When sardines and mackerel are superabundant and too distant to pay for despatch to Calicut, they are, it is said, often left to rot uselessly on the beach.

Use found for cat-fish heads and entrails.

42. A singular economy was noticed in the use of cat-fish (Arius) heads which, in several places, after the fish have been split and headed for curing, are sold to the local toddyshop keepers, who cook them with condiments and supply them with toddy to customers; presumably the strongly spiced article gives thirst or zest, like anchovies for claret or caviare for vodka.

A peculiarity in food was also noticed, viz., in the use of cat-fish entrails as food by the poorer classes; these were being sold at one pie per basket and were to be boiled with salt and chillies. No other entrails appear to be so used and the reason for this selection is unknown. The mere fact, however, and the price, and the class of people purchasing these entrails, are indicative either of great poverty or of gastronomic indifference, especially in a region where fish is so abundant and cheap. Possibly, however, the livers, forming a considerable part of the entrails, are very nutritious; in the Shetlands cods' heads boiled with the livers in the mouth, boned, spiced, and minced, form the well-known and very nutritious and tasty "stap"; cod liver oil is thus (it is said) made actually enjoyable.

43. The trade in isinglass in the shape of "fish-maws" (air-bladders of cat-fish, etc.), and shark-fins, is brisk as usual; bêche-de-mer is not found on this coast.

APPENDIX.

QUESTIONS.

I.—General Characteristics of Locality.

General nature of locality, e.g., open sea, estuary, backwater, etc., general fishing area of the locality with general boundaries (distance, North, South, East and West, or between rocks, or other natural marks or boundaries, etc.); general character of water at various seasons, e.g., clear or muddy (as in Cannanore); source and character of the "mud" if ascertainable [*N.B.*—The mud or scum is often of a non-mineral character and may be really a source of fish food]; fully saline or brackish (as near the mouth of great rivers, estuaries and backwaters); temperature at various depths at time of visit (need not be answered except by Mr. Ramanan); depths up to twenty miles from land (need not be answered, will be ascertained from Admiralty charts); nature of bottom, e.g., rocky, sandy, muddy or shelly, etc.; whether smooth, undulating, or precipitous, whether bare, or full of weeds and herbage (see Admiralty charts, enquire of fishermen, Port officers, etc.); direction of winds, and currents prevailing at various seasons; whether generally smooth or rough, periods of (*a*) monsoon, (*b*) cyclones; seasons, and whether the seasons of high wind and sea and of smooth water are fairly regular and known; whether liable to sudden storms not connected with the regular monsoons, if so, whether frequently or only occasionally or rarely, average number of days in the year when fishing is usual; whether a port or harbour exists in the locality, if so, whether accessible to boats (*a*) up to the size of dhonies, (*b*) up to the size of ordinary canoes at all times and tides; whether there is a bar, if so, depth of water at lowest and highest tides; whether there are other places of safe anchorage in case of sudden storm in the locality. If the locality is an estuary or backwater, what is its area, general depths, distance to which tidal influence extends, connection or connections with sea; whether it materially differs in size or salinity of water at various periods of the year, e.g., at monsoon time when river-fed.

II.—Fishing Population.

Its number, caste or races, intelligence, education, ignorance and backwardness, etc.

The regularity or otherwise of employment whether arising from seasons or other causes; the ordinary number of working days in the year. Subsidiary employment in the fishing and non-fishing seasons, respectively; such as the carrying of fish inland, boat-making, barrel and box-making for fish, making of new nets, including preparation of cordage, twine, and thread for the same; the collection of barks or fruits for barking the nets and lines; the curing of fish, whether by themselves or by their immediate relatives, wives, children, etc.; the drying of fish for manure and its supply either direct to agriculturists or to merchants for the wholesale manure trade; employment in the transport trade, such as, on passenger or goods boats on the backwaters, loading and unloading of steamers and

pattamars; any outside employment such as agricultural labour, etc.; the employment of the women and children of the fishermen, whether in the fishing or allied industries, e.g., curing, or in separate industries.

Any special mortality whether by accidents at sea or whether by any special diseases; general condition of hygiene and health; average age, as per census, compared with the general population.

Their general economic condition, whether well-to-do or poor; whether they suffer in time of general famine and, if so, how; indebtedness, possession of property, whether lands or houses, or boats and nets, etc. What proportion own boats including catamarans, canoes and dhonies; how they obtained these boats, e.g., whether by saving and purchase, or whether by advances; if by advances, on what terms; how they work when they do not possess boats of their own; what are their modes of hiring or leasing boats including systems of sharing the catches; what are the usual shares (*a*) to boat or net-owners or master-fishermen, (*b*) to the individuals of the crew; where fishermen do not own or hire the boats, under what condition do they fish, e.g., as paid labourers; if so, how are they paid, whether by shares or by money payment and if so, at what rates.

Who are the usual persons who lend the boats or advance money to the fishermen; are they master fishermen such as "Játi Thalavans", "Marakáyars," etc., or are they fish-curers and fish merchants and traders, or are they ordinary money lenders; what are the position and influence over the fishermen, of such persons; what is the rate of interest paid on money lent to fishermen; how are the accounts settled between the lenders and the fishermen, are advances given for other purposes than boats, nets and maintenance during non-fishing seasons and if so, for what; are the fishermen generally in debt and if so, under the greater or less control of the above class of creditors. [*N.B.*—The questions as to "Boats' should include boats, nets and all fishing gear.]

How many fishing boats are there in the locality; how many large, how many small; how many are owned by or under the control of the ticket-holders of the fish curing yard and regularly bring fish to such ticket-holders? Have the number increased in the last ten years; is boat-building going on; [*N.B.*—The words "large" and "small" have different meanings in different localities; in one place "large" will mean dhonies and "small" will be canoes or catamarans; in other places where only canoes are used, "large" will mean large canoes costing Rs. 200 and upwards, and "small" will be those costing less; hence persons answering the question should state the local meaning.] State for each ticket-holder the number of (*a*) large (*b*) small boats owned by him or under his control. (One object of this last question is to ascertain who locally controls the fishing, *e.g.*, in one large yard it was found that two Moplah ticket-holders owned or directly controlled under the advance system 46 and 52 boats respectively, which was more than all the other Moplahs and Mukkavans together.)

The possibility of Government loans to fishermen, for the purchase of boats, etc.; whether it would be acceptable to the fishermen, whether it would meet with opposition from those who usually advance money; whether there would be risks of Government losing

the money by the accidental destruction of boats, nets, etc.; for how long such loans should be granted, and for what period (dependent on the life of boats and nets).

The length of time or periods usually spent by fishermen at sea, whether in days or hours, by day or by night; reasons why they do not spend longer periods at sea, e.g., size of boats, accommodation in boats, the impossibility of keeping their catches fresh in the boats, the effect of custom and habit and domesticity in compelling their daily return; whether this class of the population is accustomed to long journeys and absence from home in dhonies and pattamars or whether such vessels are manned by other classes; whether these same classes would object to absence of a week or more at sea in big fishing boats or vessels; do these classes supply lascars to ocean-going ships or steamers? Length of time ordinarily spent in the actual daily journeys to and from the fishing grounds especially when fishing is more than three miles from land.

Do fishermen from other localities in this Presidency or from other Presidencies or countries frequent this locality; if so, in what months; are such persons increasing or decreasing in number; is their presence objected to by local fishermen; if not why not; are there operations, methods, fishing grounds, hours of fishing, boats, nets, etc., the same as those of local men? if not, how do they differ? Why do such persons leave their own homes and come to these localities? do they come of their own accord or are they induced by local merchants, curers, etc., e.g., by advances. Do they salt these goods in the same fashion as local men or differently: if differently, what is the difference? Do they take away their salted goods or are they bound to give over their catches to local merchants. How many local merchants or curers give advances to such foreign fishermen. How many such fishermen have come on their own account without any advances: how do these dispose of their catches.

Have the fishermen any grievances or hardships for which they ask consideration: if so, what are they, and what is your opinion?

III.—Deep-sea Fishing.

Note.—For the purpose of these questions, *deep-sea* fishing means fishing beyond a distance of *about* half a mile or a little more from the shore so as to exclude all nets used from the shore such as the "Karai-valai" of Pamban and other nets which are used in small canoes or by wading close to shore. Half a mile is given as the limit, because the boats which fish beyond half a mile also fish up to 10 or 12 miles, such as the catamarans of the East and South Coasts, the canoes (dug-outs) of the West Coast, etc.

In-shore will mean all fishing from or close to the shore, within *about* half a mile.

This note is necessary, because, in ordinary parlance, deep-sea fishing means fishing beyond, at least the three miles territorial limit.

Boats.—Size (length, breadth and depth), tonnage, rig, cost, duration, timber used, decked and undecked, accommodation, ability to keep the sea in roughish weather, number of crew, whether any small boat provision, seasons when used, usual fishing grounds and their distance from shore; the number and classes of nets and lines usually taken out on one occasion; duration of voyages; gear, if any, for supplementing, or in substitution of, manual labour. How are large boats of 10 tons and upwards (dhonies, pattamars, etc.) moored,

and where, during the chief monsoon on each coast? Are they hauled up on the beach; and if so, how? or, are they moored off-shore; or, are they brought into harbours or backwaters?

Nets.—Name, description with illustration, material, size (length, breadth and depth), cost, modes of manufacturing (e.g., whether made by fishermen or families or by machinery, whether in small pieces joined together or large pieces), barking (including material, bark, fruits, resins such as catechu, etc., used for barking, number of barkings required and so forth), size of mesh (including the several sizes of meshes used in a single net, as for instance in the "Odam" or Mari) and the thickness of cordage used for various classes of fish; for what fish each class of net and size of mesh are usually used; mode of using each net—e.g., whether by one boat or two, whether by simply dipping in the sea and raising as the "Odam" or by perpendicular suspension with flotes (and weights), such as the Tattu-vala and Ayiburlei; whether they reach to the bottom, or are used in midwater or near the surface; in what way are the fish caught in the net, e.g., whether by enmeshing, where head, gills, or body up to the pectoral or dorsal fins are caught in the mesh (as in the Tattu-vala and Ayiburlei), or by simple enclosure (as in the "Odam") or by enclosure in the bag (as in the "Kolli"); whether the net are stationary nets or are dragged along in the sea; whether any method of frightening the fish into the net, such as the "Tattu-vala" of the West Coast is used, or of attracting them by light or torches or other means; any objections raised by fisherman to the use of any nets; whether fishermen usually own or have at their disposal, nets of several classes, or whether each own only one sort of net; how long the several nets usually last if properly cared for; whether the nets are ever lost or destroyed by accident at sea; how long the various classes of nets have been known and used in the locality, whether from time immemorial or only recently (within a few years, as for instance, in certain localities on the West Coast); if recently, where did they come from? What reason is given by the fishermen for the adoption of new forms of net (e.g., greater success of such nets, greater demand for fish, etc.). Have the local fishermen ever tried any sorts of nets other than those they now use? if so, with what result? and why do they not now use them? Are the fish caught in the nets usually alive or dead when the nets are taken up? (*Note.*—In the "drift net" or "gill nets" in which fish are caught by the gills in the meshes, the fish are usually dead from suffocation, especially where the nets are down for several hours without being examined, as in the stationary nets put down in the evening and examined in the morning at Mangalore; this bears importantly on the question of their freshness when brought to shore.)

Hooks and lines.—Class of line used, whether the long line with many hooks suspended horizontally, such as the "Beppu" of 300 or 600 fathoms with hooks at each fathom or the ordinary hand lines; number of lines or hooks ordinarily carried by a boat; their material. How preserved against spoiling by the sea water, e.g., soaking or boiling in oil, barking, etc. Size for various fish; mode of use, whether anchored or moving; maximum length of lines and maximum depth at which they are used; what bait is used; whether any floats to regulate the depth of the hooks are used; what fishes are generally

caught by hook and line; and has the long line, if used, been long known in the locality; if not since when? Is it commonly used by all fishermen, or only by a few? In what months and in what localities and depths are hook and line (especially the long line) generally used? Do boats using the long line employ their enforced leisure while the long line is in the water, by fishing with hand line from the boat; if not, why not?

Bait.—Class of baits used for the various classes of fish; how and where procured and cost; any difficulties in getting baits; whether surface bait is used to attract sardines (as in Europe); or ground bait; whether the fish caught by the long line are usually alive when taken up or whether they are dead; whether shell-fish, e.g., mussels, whelks, coackles, etc., are used as bait; if not, why not?

Preservation of Fish.—How are fish kept good until brought to shore, e.g., when several days caught, as in some Ratnagiri boats, or whole night or day, as in other boats; are the fish when brought to shore fresh enough to be sold as fresh fish or are they somewhat tending towards tainting or tainted especially in the hot weather; if at all tainted, what is done with such fish? Is any special method adopted at sea to keep fish untainted or alive, e.g., sprinkling with (bazaar) salt, if dead, or keeping the fish alive in a coir bag or net towed overboard, or in a receptacle or partition of the boat containing sea water, or in a separate covered small boat containing sea water; are fish ever brought alive to shore, by making use of such receptacles, bags, etc.; has any such method ever been tried (until ice was adopted, in England, etc., this was the habitual method used). Whether boats are employed to run backwards and forwards between shore and fishing ground to take catches to shore as quickly as possible and as soon as possible after catching; whether fish-purchasers, curers, traders, etc., send out boats to purchase fresh fish direct from the fishermen while still at sea, as on the West Coast.

IV.—In-shore Fishing.

The above questions with the necessary exceptions and changes apply to in-shore fishing.

V.—Estuary and Backwater Fishing.

Similar questions.

VI.—Produce and Production of Fish.

Complete list in the Vernacular (both vernacular and Roman characters; spelling and transliteration to be *very carefully* done), English and Latin, when possible, of all fish caught in the locality as ascertained and identified by careful enquiry or actually seen. Any duplicate names to be also given, since fish even in the *same* language are frequently known by more than one name, sometimes according to locality, age of fish, etc., conversely, different fish having the same name or generic name to be carefully distinguished, e.g., there are said to be 14 or more kinds of fish all classed as "Yeta" (cat-fish) of one kind or another, as "Bengadi yeta," "Kalli yeta," "Valia yeta," and "Thuri yeta," etc. Description of such fish regarding any matters

not found in the text-books. Abundance or rarity to be expressly noted with seasons of such abundance or rarity.

The usual dates from observation and enquiry (*a*) of containing milt or roe (*b*) of spawning as judged (1) by the months in which the ova are found ripe, (2) by the months in which the fish are found empty (e.g., sardines and mackerel on the West Coast are full of roe in June and July and empty and fat in October and November); localities of spawning if ascertainable, e.g., whether open sea or in-shore, whether the ova are pelagic or demersal, adhesive or separate; general number of eggs in the fish, i.e., whether only a few dozen of large eggs or many thousands of minute eggs; time occupied between spawning and hatching (probably this is not yet ascertainable until experiment can be undertaken); any peculiarities of spawning or hatching as in the cat-fish; chief food of the fry; chief enemies of spawn and fry.

Chief seasons at which the respective fish usually appear or are in greatest abundance; any cause for appearance or non-appearance of fish at such seasons or localities, e.g., appearance of ooze or fish food in the waters, currents, or winds or changes of temperature; in the case of predaceous fish, whether they are following smaller fishes (e.g., observe contents of stomach); any observation tending to show the direction from which they come, e.g., from open sea to in-shore direct, or from northward or southward; whether statistics or evidence indicate any diminution or increase of catches, whether of particular species, or of fish in general, on an average of years, e.g., quinquennia or decades. Is there reason to suspect that shoals visit the coastal waters every year but are missed by being at some distance from land, e.g., more than 5 or 7 miles out? Are fishermen prevented, e.g., by the small size of their boats, from going out to sea to search for the missing shoals? Do they usually do anything more than wait near the shore (within 3 or 4 miles) in hopes of shoals appearing?

What are the chief spots or grounds where fish are most abundant; what are the chief characteristics of such places; any assignable reasons for habitually small catches in various localities as on the East Coast generally; for instance, want of demand or market or means of transport, want of proper boats and appliances, absence of fish in the sea, shallowness or muddiness of water, and so forth.

Quantities *caught* in the locality as judged (*a*) from the estimated quantities used locally or sent inland, (*b*) by statistics from fish-curing yards, (*c*) by estimate of quantities taken as manure (e.g., quantities sent to large merchants like Peirce Leslie & Co., areas of gardens to which it is sent, etc.).

The maturity or otherwise of fish caught, especially in in-shore fisheries, whether fry and immature fish of the chief food species are largely caught, and, if so, of what sizes; and in what months or seasons and in what sort of nets (e.g., the "Karai-valai of Palk's Straits). (*Note.*—The fry and young of fish which grow to a good size must not be confounded with small fish of species which never grow large.) What are the causes of immature catches, e.g., smallness of mesh; whether the catching of such immature fish and fish fry is intentional or otherwise; whether the fishermen could be induced to return to sea, fry or very immature fish caught alive and uninjured, in nets such as the "Odam."

Have any new European methods of catching fish been attempted, such as steam-trawling; if so, when and with what results, and what reasons are assigned for the result? Whether any methods of pisciculture are known or practised, i.e., the hatching or breeding of fish by (*a*) natural, (*b*) artificial means; for instance, are mature fish conveyed or enticed into enclosures in estuaries or backwaters and kept there to spawn (natural pisciculture); or are fish anywhere caught and the eggs taken from them, fertilised and artificially hatched (artificial reproduction); or are eggs collected from places of deposit and placed in localities favourable for hatching; are any methods practised of catching and fencing in young fish or fry (whether of fish or of shell-fish such as prawns, oysters, lobsters, etc.) and keeping them until they mature. (*N.B.*—All questions relating to fish are intended to include all classes of shell-fish, e.g., lobsters, oysters, crabs, cuttlefishes and so forth.) Are oysters, mussels, or other shell-fish transplanted, when young, to favourable localities? Is there any native demand for shell-fish; if so, of what class principally? Is the demand for food or for other purposes such as bait? What special modes or implements of catching and keeping alive to the market are adopted for crabs, lobsters, etc.?

VII.—Distribution.

Modes of disposal of the fish when brought to shore by fishermen, whether by auction, by private bargaining, by transfer to merchants, curers or persons from whom advances have been received; whether the fishermen take or send by relatives their fish to the fish-market or whether they make arrangements for sending it inland by partners, relatives or coolies; what persons generally conduct the fresh fish trade, whether on the sea beach, or in the fish-market, or by hawking it in the streets, or by carrying it to inland villages?

What is the condition of the fish when brought to shore generally; is it alive or dead, firm and rigid or flaccid; is it becoming or has it frequently become decomposed or tainted; note specially its condition in the hot months. Is any difference in freshness observable between fish which are always alive when taken into the boat, e.g., those caught in "Odam" or other dip-nets or by hand line, and those which are frequently dead when taken into boats, e.g., those caught and suffocated in gill-nets, especially those which are down for long periods (as in the nets which remain set all night at Mangalore), and fish caught on the long line which are frequently found to be dead when taken up? Distinguish also between fish caught by boats which go out in the morning and come back in the afternoon and fish caught by boat such as (Ratnagiri) boats which go out in the afternoon and come back in the morning; in what condition is the fish which is brought in by those Ratnagiri, etc., boats which stay a week or more at sea; how is such fish kept from being tainted; is such fish classed as fresh fish or is it only fit for salting; if salted at sea, how much salt is used. What is the general condition of "fresh" fish which has been taken ten miles or more inland? Is it fresh or slightly tainted or bad especially in the hot weather: does it find a ready sale, whatever its, condition? Have you heard or have you any practical suggestions for improving the fresh fish trade on its present lines?

Are there any regular *markets* for fresh fish in the locality; if so, who are the sellers, whether fishermen or persons who have purchased from the fishermen, or fishermen's relatives; to what caste or nationality do they belong; are there any steps taken to keep the fish good after having been brought to the market, e.g., use of salt water baths, nets to keep off flies, and so forth. Do the municipality, if any, levy any stall-tax; do they provide aids for keeping stalls clean and fish sweet or do they enforce penalties if the stalls are not kept clean? What fish are generally most abundant at such markets? What fish are most in demand for consumption? Are fresh fish sold by weight or by number or in what way; are the eggs or roe of fish sold separately from the fish, e.g., roe of seer, hilsa, etc., eggs of cat-fish and so forth; if so, at what prices; whether fresh fish is sold always for ready money or whether accounts are kept; how many persons daily sell fish at the market; if stalls are rented, how many are there so rented; any suggestions made by the fish-sellers for the improvement of the business. What is done by the fish-sellers with any fish that are unsold during the day? Give the prices obtained by (*a*) fishermen on the beach, (*b*) at the market for fresh fish, both at ordinary times and on occasions either of great abundance or rarity. What is the ordinary difference in price of fresh fish (*a*) on the beach, (*b*) at the market, (*c*) at ten miles inland. Is there a ready sale for all fresh fish taken inland at the prices demanded? What is the ordinary difference in price in the locality of (*a*) fresh fish bought by the curers, (*b*) of fish cured at the fish-curing yard, e.g., if fresh fish be bought by the curers for Rs. 10, what will be the selling price of the same after being cured?

Give all information procurable about the inland fresh fish trade, e.g., persons conducting it, distance to which it is carried fresh, prices charged as the distance increases, mode of selling the fish taken to a distant village and so forth.

Curing.—How many ticket-holders are there at the fish-curing yard; what are their castes or nationalities and how many of each; in what relation do they stand to fishermen, e.g., are they relatives (wives, brothers, etc.), or persons who advance money or lend boats to the actual fishermen, or are they simply purchasers of fish; how many of the ticket-holders are big men and either own several boats or control the catches of several fishermen; in what way do they obtain control over the catches of the fishermen, e.g., whether by advance or by leasing boats to fishermen or by employment of coolies in their own boats; is most of the fish caught brought to the fish-curing yard, or only such as cannot be sold fresh?

Describe the methods of cleaning and gutting (*a*) large fish, (*b*) small ones; what is done with the guts, heads, etc., e.g., whether they are left on the beach or thrown into the water, or taken away for manure or as food for poor classes, use in toddy-shops, etc.; for what trees or crops are they considered the best manure?

What method of curing is adopted in the yard or by private persons outside the yard; is the fish frequently tainted when it comes for being cured; are maggots observed in the fish either when brought in the yard or in the process of curing. In the curing processes are the fish washed in fresh sea-water *after salting* and before drying; if so, is the sea-water brought into the fish-curing yard or are the fish

taken down to the sea; if not so washed, why not; do washed fish fetch better prices or keep better than unwashed fish? (*Note.*—This does not refer to the usual washing in the sea after gutting and *before* being taken to the fish-curing yard, but to washing in sea-water *after* the fish has been lying in salt in the yard; it is [e.g., in Tellicherry] an important but seldom used part of the *curing* process).

What is the direct destination of the fish cured in the yard (*a*) large, (*b*) small; what is the general value of cured fish as compared with fresh fish, e.g., if fresh fish be bought for Rs. 10, what will be the value of the same fish when cured; how is cured fish sold, by number or by weight, give instances; where cured cat-fish or seer, for instance, are of various sizes, how are they sold; in what way are dried fish packed for export by (*a*) sea, (*b*) land, e.g., in date-mats, baskets, bundles, etc., how long will properly cured fish keep in good condition; will it keep good during the south-west monsoon on the West Coast; if not, why not; does foreign (e.g., Persian Gulf) salt-fish keep good during monsoon; if so, why? Has the cured fish trade (*a*) import, (*b*) export, increased or decreased in the locality of late years; if so, since when, and to what extent, and what are the causes; are there more or fewer merchants engaged in the trade; is more fish being cured in the fish-curing yard than ten to twenty years ago, if so what are the causes? has it been found necessary to open subsidiary yards in the immediate locality (as at Malpe) in consequence of the increase; has any been closed and if so, why?

Are any other modes of drying and curing fish known locally besides the ordinary salting and drying of the fish-curing yard, e.g., wet salting in barrels or jars, drying and smoking, canning (tinning), preservation in vinegar in barrels or jars with or without condiments, etc. If smoking is known, what woods or other material (e.g., paddy husk) is found to give a desirable flavour? Do any of the curers or merchants know of the above methods; are they inclined to try them? if not, why not? what objections or difficulties do they raise? What are the prices at which barrels of different sizes and of ordinary wood such as mangoe are or can be made? if made in large quanties could they be made cheaply; could stoneware glazed jars be made locally, and if so, at what prices for various sizes? What is the price in the bazaar of English stoneware glazed jars of various sizes?

State any grievances of any nature which the curers may bring to your notice; give your opinion on such grievances, whether for, or against; also any suggestions by curers or yourself for any improvements, whether in the processes of curing or in the fish-curing rules. What is the latest time at which the yard may be kept open; do you know, either personally or by information, of cases during the last three years in which loss has been caused to fishermen or curers by the rigid closure of the yard at the regulation hour; how is such difficulty got over, licitly or illicitly; can you make any suggestions in the matter, such as payment of fees for overtime to the yard officers, or extra establishment at large yards in the busy season, etc.? Can you suggest any method by which duty-free salt, at the price of such salt in the fish-curing yards, could be supplied to large boats so as to enable them to keep at sea for several days and to salt their fish on board? e.g., by requiring all such boats to show their catches at the fish-curing yard and to account for the salt expended by showing a

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proportionate weight of salt fish. If such fishing were under the control of a few big men would it be less difficult to frame such rules than in the case of small fishermen?

Have any capitalists, European or Native, shown any inclination to take up the fishing and curing industries; what difficulties have been alleged as preventing or hindering or as having actually hindered or crushed such enterprise? Do any people deal in fish for manurial purposes? if so, how are they supplied with the necessary fish, e.g., do the fishermen dry on the sand any surplus fish and send it to the merchants from time to time, or do they take fresh fish to the merchants; what are the chief fish used for manure?

Other Products.—Is fish-oil manufactured in the locality, if so, what oils? What are the processes of manufacturing it including (*a*) the extraction of the crude oil, (*b*) any purifying processes. If various processes are used (e.g., extraction by boiling, by pressure, by mere exposure in masses to putrefaction), state them. What proportion of (*a*) crude oil, (*b*) refined oil is obtained from a given quantity of fish or fish liver, e.g., for one pot of crude shark or sardine oil, how many pots of shark liver or sardines are required and how much refined oil is obtained from one pot of crude oil? What is the character of the product, is it fit for the export market or is it only used for caulking boats, etc.? Is any fish-oil used medicinally, if so, what; if the trade does not now exist, did it formerly exist in the locality; has it increased or decreased; give reasons in either case. Is any decrease or cessation of the fish-oil trade due to decrease or cessation of the *trade demand* or to decrease or cessation of the *supply* by manufacturers: In either case, give reasons for the same. Is the decrease or cessation apparently permanent or only temporary? What trade is carried on in fish-maws (air bladder and sounds), shark fins, *beche-de-mer* and other miscellaneous produce of the sea, as sponges, window-pane oyster, turtle and other shells, etc.; what quantity is exported annually and to what places? Shark fins are divided in the trade into "black" and "white", the latter being several times more valuable than the former: are these respectively the fins of different fish? if not, what causes the distinction between white and black? Is it anything in the method of curing or what? Can you suggest any improvement in the curing of the "fish maws" so as to improve their selling value? Does sea weed abound in the locality and, if so, is any use made of it, either as manure or for the extraction of iodine or otherwise? Is any sea weed considered as edible and used for food either locally or exported? Do you recognize among the sea weeds any species useful economically?

Order of the Government of Madras, No. 1083, Revenue, dated 30th October 1906.

In paragraphs 15, 27, 28 and 29 of his letter No. 26, dated 5th February 1906, Sir Frederick Nicholson made the following suggestions with the object of promoting the development of the fish-curing industry:—

(1) that duty-free salt should be allowed to be taken to sea in fishing boats for curing purposes;

(2) that the hours during which night work is allowed in fish-curing yards be extended;

(3) that facilities should be provided for curers cleansing their salt fish in the sea at or near curing yards; and

(4) that the issue price of salt in the yards of the Malabar district should be reduced to As. 10 a maund.

2. These suggestions having been referred to the Board of Revenue for remarks, the Board recommends that the first and second concessions may be granted subject to certain conditions and that, as regards the third proposal, the matter should be left to the discretion of local officers on the understanding that the practice will be permitted wherever it can be done with safety. In reference to the fourth proposal, the Board points out that the grant of the concession would involve a considerable loss of revenue.

3. The Government approve of the Board's recommendations in regard to the first three concessions subject to the following remarks:—

(*a*) *Concession No.* (1).—The Government consider with reference to condition 4 of the conditions suggested by the Board that the difference between the issue price and the cost and duty value of the salt should not be recovered except when the deficiency exceeds 10 per cent. of the quantity originally issued.

(*b*) *Concession No.* (2).—The Government do not consider that overtime fees need be paid or collected *in advance*.

4. As regards concession No. (4), the Government are of opinion that though there may be some immediate loss of revenue, there is a fair prospect of this being made good before long by the increase in the issues of salt which may be expected to result from the reduction in the price of the salt used for curing. They accordingly sanction the reduction of the price to As. 10 a maund as recommended by Sir Frederick Nicholson.

RESOLUTION OF THE BOARD OF REVENUE, No. 7/87-R., SALT, DATED 8TH JANUARY 1907.

Communicated to Deputy and Assistant Commissioners and Officers in charge of Coast Circles for information and guidance.

2. Duty-free salt for curing fish at sea should be issued only to respectable boat-owners and the following instructions should be followed:—

(1) A list of persons to whom the concession is granted should be kept in the fish-curing yard and separate accounts in Forms F.C. 3 and F.C. 3-A. maintained for them. The transactions should also be exhibited separately in F.C. 6 and F.C. 7.

(2) Salt should be issued in reasonable quantities on payment by the boat-owner of the value thereof and on execution of an agreement in the form appended to these Proceedings.

(3) The boat-owner should be directed to bring all fish cured at sea together with the balance of salt not used for curing direct to the fish-curing yard for weighment, immediately on return of the boat to land. The balance should be kept separately in the yard and re-issued to the boat-owner free of cost and after weighment. An entry to this effect should be made in the remarks column of F.C. 3-A.

(4) In such cases the quantity of raw fish should, for the purpose of entry in F.C. 3, be calculated on the weight of the cured fish after allowing for the usual dryage.

(5) The officer in charge of the fish-curing yard should fix the proportion of salt required for curing fish, separately for large and small kinds, and this rate should be checked by the Inspector and entered in condition 6 of the agreement.

(6) No recovery need be made from the boat-owner when the deficiency in the quantity of salt is 10 per cent. or less, but when it exceeds 10 per cent. the difference between the cost price and duty, and the issue price should be recovered from him. In clear cases of fraud double duty should be levied on the quantity of salt issued.

(7) The establishment at the fish-curing yard should examine boats frequently before leaving for and on return from the fishing grounds.

3. Night work may be allowed in fish-curing yards after the prescribed hour on written applications from the curers, provided that the minimum quantity of salt applied for by them at one time be not less than 5 maunds. Overtime fees should be collected from the curers in advance, but should be recovered from them rateably according to the quantity of fish cured before it is removed from the yard. A uniform rate* for Sub-Inspectors, Petty officers and peons has been prescribed for each hour of overtime work. The fees collected should be entered in F.C. 4 and credited in the nearest treasury as in the case of ordinary fish-curing receipts. The amount should be drawn on monthly bills paid in full to the officers concerned after sanction by the Assistant Commissioner.

Overtime fees for each hour.	A.	P.
* Sub-Inspectors	6	0
Petty officers	1	6
Peons ...	1	0

4. In cases where fishermen desire to take the fish to the sea at or near fish-curing yards for the purpose of cleaning it, they should be permitted to do so under such departmental supervision as the Assistant Commissioner may consider necessary.

APPENDIX.

Form of Agreement.

This indenture made the day of 191 between The Right Honourable the Secretary of State for India in Council (hereinafter referred to as the "Secretary of State," of the one part and of (hereinafter referred to as "the boat-owner") of the other part whereas the boat-owner is the owner of boat number at the port of in the District of in the Presidency of Madras and the nets belonging to such boat the measurements and particulars whereof are set out in the schedule hereto annexed and whereas the boat-owner has applied to the officer in charge for the time being of the Salt Department at fish-curing yard for the issue to him the boat-owner of salt for the purpose of curing fish caught at sea before such fish is landed at aforesaid and has requested that such salt may be issued to him duty free and whereas the said application has received the sanction of the

Inspector, Salt, Abkári and Customs Department, Circle, upon the terms and conditions hereinafter contained WITNESSETH as follows :—

(1) The officer for the time being in charge of the Salt Department at fish-curing yard will from time to time supply the boat-owner with such amount of salt as the boat-owner may require on any trip for the purpose of every fishing trip taken by such boat-owner for which salt the boat-owner shall duly execute a proper receipt in the form laid down from time to time by the Deputy Commissioner, Salt, Abkári and Customs Department, Division.

(2) The boat-owner undertakes to use the salt so supplied to him for the sole purpose of curing fish whilst at sea and not for any other purposes.

(3) The boat-owner shall bring all fish so cured at sea together with the balance of any salt that may not have been used for curing during any trip immediately on return of the said boat to land and direct to the fish-curing yard at for weighment.

(4) The unused salt shall be weighed and taken over by officers appointed for such purpose by the Secretary of State.

(5) The boat-owner shall pay for all salt issued to him for curing fish at the rate in force for the time being at the said fish-curing yard.

(6) The amount of salt used for curing fish shall be taken at the rate of maunds of salt for maunds of salted fish and this proportion is subject to revision. In case of any deficiency between the amount of salt originally issued and the amount returned exceeding 10 per cent. of what the amount of deficiency should be calculated at the rate aforesaid the boat-owner shall forthwith pay the Government of Madras for the deficiency in excess over such 10 per cent. the difference between the cost and duty value of salt in force for the time being at the said port, and the issue price of salt.

(7) The Secretary of State and his officers and servants shall at all times have full power and liberty to examine the said boat and nets before leaving for and on return from the fishing grounds.

(8) In case of breach of condition 2 hereof or in any case of fraud as to which the decision of the Deputy Commissioner of Salt, Abkári and Customs Department, Division, shall be final the boat-owner shall pay double the duty for the time being leviable on the quantity of salt issued.

AND THIS INDENTURE ALSO WITNESSETH that in consideration of the premises the boat-owner doth hereby assign to the Secretary of State his successors and assigns the boat and nets respectively referred to in the said schedule by way of as security for the payment of any amount for which the boat-owner may be or become at any time or times hereafter liable to pay to the Secretary of State under the conditions hereinbefore mentioned and that if default shall be made in the payment of any such sums so payable by the boat-owner the Secretary of State or any officer of his duly authorized in this behalf shall be entitled to sell the said boat and nets or any portion thereof and apply the proceeds thereof towards the payment of moneys due to the Secretary of State hereunder and the surplus if any shall be handed over to the boat-owner.

Provided also that it shall be lawful for the Secretary of State hereto to forthwith put an end to this agreement on giving to the boat-owner notice in writing signed by any officer of Government on his behalf of his intention so to do and that the boat-owner may put an end to this agreement on giving the officer in charge of the Salt Department at fish-curing yard six weeks' notice of such intention.

In witness whereof the Deputy Commissioner, Salt, Abkári and Customs Department, Division on behalf of the Secretary of State and . . . . the boat-owner have hereunto set their respective hands the day and year first above written.

The Schedule above referred to.

Signed by the above named in the presence of

Signed by the above named in the presence of

This concession has not yet been availed of by the fishermen, as there no large sea-going boats have yet been built, and the Ratnagiri (Bombay) boats are less numerous in Malabar and South Canara than before owing partly to liberal Bombay rules.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., I.C.S., Officer on Special Duty, Fisheries Investigation.
Dated—Madras, the 28th February 1907.

In paragraphs 186 to 195 of my report on Japanese fisheries I have suggested the early establishment of an experimental station, probably on the West Coast.

2. As will be seen by paragraphs 216—224 of the report and by the letters of this date, I do not propose to start this experimental station *at once*, for the simple reason that I have neither men nor plant, and that while I could obtain and put up the plant in a year, I could not get trained men in anything like that time, except by introducing foreign experts at very great expense, a plan which I do not advocate.

3. My object in entering the proposal was (1) to make with some degree of completeness the more obvious suggestions which arise out of my Japanese studies, (2) to place *definite* aims and objects of action before us, so that knowing our objects, we may at once begin to make the necessary provision in trained experts, staff, etc. Without such statement of objects the matter would have been left nebulous; I wished to reduce nebulosity to definite form and not only to show what action should be taken, but the necessary steps preliminary to that action. Without experiment, no clear progress; without experts, no useful experiment; without directive agency, no definite or controlled experiment; without experts or experimental stations, no useful department: progress, experimental stations, the provision of experts, the formation of at least the nucleus of a department, are all interdependent and I have therefore both in the report (paragraphs 186—224) and in these several covering letters, made my proposals under all the above heads.

4. In the present letter I propose simply that Government will be pleased to lay down in their ensuing order the necessity for an experimental station with the objects and aims mentioned in paragraphs 186 to 194 of my report, and for immediately working up towards its establishment. Should Government accept the general idea I would suggest the West Coast, as the more advanced and busy coastal area, for the first station. Tellicherry as the location, for the following reasons: (*a*) it is a central point on the West Coast; (*b*) there are

a number of merchants, European and Indian, who do business there in fishery products partly for inland, partly for foreign (Ceylon, Straits, China, etc.) trade ; (*c*) it is well frequented by various classes of fish (*d*) its products are already favourably known, as processes are said to be more careful ; in other words, there are the germs of industrial and trade progress there ; (*e*) there is a French manufacturer of Mahè who makes very fair and cheap canned goods (fish) at his factory just inside British territory near Tellicherry, and it may be advisable to try and enlist his services as instructor in that branch of curing ; (*f*) it is well adapted for observing the facts and conditions not merely of the trade and industry, but of marine fish life.

5. As regards point (*e*) I have dealt more fully with this suggested enlistment of the French canner in my letter No. 88 (*e*) of this date relating to the training of our future experts.

I

Letter—from Sir F. A. Nicholson, K.C.I.E., I.C.S., Officer on Special Duty, Fisheries Investigation.
Dated—Madras, the 28th February 1907.

In paragraphs 196 to 212 of my report on Japanese fisheries I have suggested certain fresh-water piscicultural methods by carp hatcheries, etc.

2. As mentioned in my No. 88 (*c*) of this date on the future establishment of experimental stations, I do not propose the immediate starting of large hatcheries; I have not the experts to put in charge, nor would it be well to embark without more experimental and therefore precise knowledge, on larger work.

3. But my assistant Mr. V. V. Ramanan is, as I have elsewhere several times said, already an experimenter and observer in Natural History, and I propose during this year not only that he shall thoroughly examine the proposed sites of hatcheries, viz., near Nellore and Kurnool, and the waters to be stocked, but shall begin experiments in Madras in small culture ponds where he will breed various classes of carp, observe their habits as regards spawning, their food, rates of growth, and in fact the whole life-history of various sorts of fish. At present we have no exact knowledge—essential for hatchery work—of important matters of reproduction such as the time of year, whether only once in a year or repeatedly, the place or conditions of spawning, or even the character of the eggs (floating, demersal, adhesive, etc.); of the best and at the same time the cheapest food available, and of the possibility of good profit by the deliberate breeding and feeding of fish in stock ponds; of the fish which will give the best market profit, food, weight, etc., being considered. These and many other points I propose to examine by observation in experimental ponds.

4. For carrying on these experiments on the larger and more continuous scale I shall of course require trained men, and it is for this reason that I have proposed the training of a student at the Fishery Institute, Japan, in the cultural branch. I also want men as itinerant instructors who will go about the country suggesting and assisting the utilization of small village waters (paragraphs 202, 206—209, 225—227); these will

require training either in Japan or in the hatcheries when once established in this country, or at the proposed Madras experimental ponds.

5. What I now ask Government in this letter is that, if so pleased, they will sanction the general idea of carp, etc., hatcheries and the proposed utilization of inland waters, and the acquisition on lease of some location in Madras where my Assistant can (reside and) conduct his important experiments; he is now engaged, *inter alia,* in searching for some such place, and I will report further on receipt of the general order now sought. The experimental station at Coimbatore can doubtless be carried out by the authorities of the Agricultural station there.

ORDER—No. 733, REVENUE, DATED 1ST APRIL 1907.

With his letter of the 28th February 1907, which was disposed of in G.O. Mis. No. 664, Revenue, dated 20th March, Sir Frederick Nicholson submitted his report on fisheries in Japan. In this report Sir Frederick Nicholson has given the result of a ten weeks' tour in Japan last year and has brought together a large amount of information regarding the progress of fishery work and its modern methods of development, especially by Government institutions, in that country.

2. In the letters read above Sir Frederick Nicholson summarizes the proposals, which appear also in paragraphs 186—212 and 216—224 of the report on fisheries in Japan, for giving practical effect to the results of his enquiry. These proposals are as follow:—

(1) The establishment of an experimental Fishery Station on the West Coast preferably at Tellicherry with the objects and aims mentioned in paragraphs 186 to 194 of the report;

(2) the establishment of carp and other fresh-water fish-hatcheries in suitable localities and as a preliminary measure thereto, the employment of M.R.Ry. V. V. Ramanan to examine the proposed sites of the hatcheries and the inland waters to be stocked as well as to conduct experiments in Madras in small culture ponds in breeding carp and other fish and observing facts connected with their life-history; and

(3) the deputation of three students to Japan to learn the methods of catching and curing fish there followed so as to provide the expert staff required to carry on the work connected with the Fishery station and inland hatcheries mentioned above.

3. The Government approve generally of the first two proposals and sanction the leasing of a house in Madras for such period as Sir Frederick Nicholson considers necessary to enable M.R.Ry. V. V. Ramanan to conduct experiments in fish culture, the necessary details being submitted for approval of Government. Sir Frederick Nicholson will doubtless make further enquiries in his forthcoming tour in Europe, America and Japan regarding the plant required for the Fishery station and will submit detailed proposals and estimates.

4. With regard to the proposal to send students to Japan, the Government fear that the students would be unable to obtain in the short time at their disposal sufficient knowledge of the Japanese language to enable them to profit by the instruction given. Sir Frederick Nicholson recognizes this difficulty and the Government, after careful consideration, are of opinion that it would not be wise, without further information, to send students to Japan, and that if possible they should be sent at any rate in the first instance to England or America.* Sir Frederick Nicholson will accordingly be requested to make further enquiries during his coming tour as to whether the desired training cannot be obtained in those countries.

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* The idea of sending students to Japan was abandoned ; the chief reasons were the language and other difficulties, and—mainly—the fact that in November 1907 Mr. H. C. Wilson was appointed as Piscicultural expert, and in 1908 Mr. James Hornell, F.L.S., was also brought in as Marine Biologist and Assistant and Superintendent of the Pearl and Chank Fisheries. With these experts in the department and with the several experimental stations, fish farms, hatcheries, etc., in operation it was felt that students could be trained within the Presidency.

II

Letter—from Sir F. A. Nicholson, K.C.I.E., I.C.S., Officer on Special Duty, Fisheries Investigation.
Dated—Madras, the 28th February 1907.

I have the honour to lay before Government the necessity for initiating a small Bureau of Fisheries for Madras. I purposely do not call it a department considering that it should, for some years at least, be an appanage of Agriculture; it should, for the present, consist of a small but permanent and efficient staff under the control, presently, of the Agricultural Department.

2. That every civilized country possesses a Fisheries Department or Bureau, besides other fishery organizations; that such departments have worked great benefits to the industry, trade, and people; that the industry of third importance in the country demands the special attention of its Government; that when such industry is in a primitive condition, without capital, initiative, or knowledge other than traditional, some considerable stimulation and assistance *ab extra* are essential to progress, are mere truisms, but not the less cogent as general arguments in favour of at least a bureau for Madras. In a country so advanced, progressive, and individualistic as the United States of America the Federal and State Departments have worked vast improvements by their researches, hatcheries, transplantations, legislation, protection; in a depressed country like Ireland, the new department, following up the work of the Congested Districts Board, is doing very great stimulative and productive work.

3. But it is Japan which teaches the power of a well-organized department upon an industry in a position of some original similarity to our own, in stimulating development in every branch—whether of catching, preserving, or cultivating—of an industry conducted, as in India, on primitive lines; in developing associated work and sound trade methods and processes through laws worked by its administrative officers; in establishing numerous experimental stations where new methods are both tried, demonstrated, and pushed; in giving popular instruction not merely in regular fishery schools, but through these stations and their itinerant experts and by frequent exhibitions; in sending abroad men for

study in fishing ports and vessels, factories, exhibitions, etc., in every branch of fisheries ; in importing experts and in advertising Japanese goods in foreign markets by liberal subventions for displays at exhibitions under the guidance of experts, by the issue of printed information, and so forth. What Japan has done and Ireland is attempting—I mention these two countries because of the nature of the problems faced by their departments—Madras can and should do.

4. I was originally deputed to study and report on Madras conditions and to make suggestions ; I intended to have dealt with the matter this summer in a general survey which should form the basis for proposing a department and staff. But while on the one hand my visit to Japan and America has delayed my consolidated report by the best part of a year, as expected in my letter proposing to visit Japan, it has on the other hand enabled or rather obliged me to anticipate that report especially when considered with the contents of my West Coast report and those about to be presented in reports on the East Coast. For we now know that the lead of Japan in the institution of experiment is the correct one, especially in a country where private action waits on Government demonstration ; we require institutions where we can investigate new implements and new methods, and can display and teach them. Hence in my Japanese report I have proposed, and in covering letters have urged, the early establishment of an experimental station, and of experiments on inland hatcheries for carp, etc., and these, at least the former, must develop in number as the East Coast is examined and new problems are taken up such as many sorts of culture, the transport of fresh fish, etc. For the proper and continuous control of such a station or stations and hatcheries, for the wise selection and direction of experiments and the co-ordination and display of results, a directive and expert officer and staff are required. Experiment is essential to progress ; for the due conduct of experiment, a proper staff is necessary.

5. This however is only one point ; the examination of Madras fishery conditions shows that there is increasing work for an indefinite period such as cannot possibly be done offhand by a single officer, without sufficient

status and with an office not sufficient even for clerical work. Japan began internal work with a strong Commission simply for local enquiry ; this went on for some years till the necessity for a department became apparent if only to take up the Commission's work systematically ; it is so in Madras. The mere survey of our coastal seas and estuaries is a huge task ; I do not mean the mere gaining of a general knowledge of fisheries and their conditions, though this is vast enough, since the character of the sea, the class of men occupied, the conditions under which they work, differ every few miles ; I mean rather the accurate examination of the seas and shores, the suitability of areas such as the Pulicat lake and other backwaters for special cultures such as oysters and other shell fish, the character of comparatively enclosed seas such as Palk Straits which are believed to be a great fish nursery (Herdmann), the quantitative testing of the waters to, say, the 100 fathom limit, by methods such as trawling (part of the work of experimental station), etc. The survey of inland waters in view to the possible development of fisheries is a labour of the greatest difficulty owing to their too temporary character and to the vested interests under which they are already utilized.

6. I need hardly point out that in several other directions a department is essential both for action and guidance ; *administratively* to deal with the problems that emerge from practice, especially as it develops, such as the study of the effect of developed fishing on the fish and fisheries especially in almost closed areas like Palk's Straits, and such protective or other action as might become advisable ; the regulation, if necessary, of classes of nets and meshes or of fishing methods or of fishing seasons ; the protection and advancement of the fishing classes as by stimulating co-operative effort alongside of company enterprise, by establishing financial assistance, by providing instruction in the use of improved methods and plant, by deciding or allaying fishery disputes, by the inspection of food and manure stuffs in view to the supply of wholesome and warrantable goods ; the pushing of trade interests as by stimulating the exhibition of the best goods in exhibitions in India and abroad, by the award of prizes for new or improved methods and goods or apparatus, by the collection and distribution of

information, by obtaining and improving railway connections and transport facilities, and so forth.

Cultural such as the establishment of hatcheries marine—if necessary—and inland, the cultivation of the pearl oyster and the artificial stimulation of pearl growth, the cultivation of many classes of shell fish especially of the edible oyster, mussels, clams, etc., in our shallow backwaters if only for export, dried, to the Far East, the propagation of the chank which, by the statistics, seems to be falling off in numbers and size, the artificial growth of sponges, and so forth, all of which, except the chank, are actualities in other waters, chiefly Japanese, and all are promising possibilities here.

Scientific as in the observation of the bionomics of fish, their habits, age and size at maturity, seasons and places of spawning, food, conditions and seasons of their approach to land, the reasons which determine such approach whether food, temperature, winds, currents, etc., the causes of their putting out to sea whether natural or due to human action (such as the use of clamorous methods of capture, the frequency of steamers with noisy propellers, etc.), and many other scientific questions of practical utility.

Statistical, for at present we know little of the amount of catches, their respective values at the beach and in the market, the respective shares of the fisherman, middleman, money-lender, fishmonger, the distance at which caught, and the amount caught per boat and man, facts of immense importance in judging of the increase or decrease of fish in our waters ; the number, size, cost, etc., of the boats employed, and the conditions and wages of employment, facts essential if we wish to gauge the growth and modes of growth of a trade ; the quantities, values and destinations of various kinds of cured fish, etc.

Industrial as in the development of those by-industries which tend to the profit and enlargement of the trade, such as the improvement of the material, net-making methods, the barking of nets, the making of barrels and jars for pickling, the preparation of manures and fish oils, the utilization of sea and fresh water shells, and so forth.

7. While it is not pretended that these functions would be otherwise than of slow development we are

bound to recognise that these are necessary functions, that they should be begun, and will have to be developed; that an immediate nucleus should be formed is my present claim, in view even of the modest proposals which have arisen on my Japanese studies. Japan in fact already performs all these functions and more.

8. There is a further and immediate reason for forming at once an embryonic Bureau, and that is the necessity for recognizing my office and giving it a proper status. The term of appointment of my assistant and two clerks expires on the 30th June, so that the present is a fitting time for discussing the question. If the work is to go on, the office must be continued, and, if continued, it must (*a*) be given a status, (*b*) enlarged.

9. *Point* (*b*).—The establishment of an assistant and two clerks was a purely tentative and guess work arrangement; the assistant was to help in my tours, the clerks to do the clerical and account work. But as the work took shape, the staff proved insufficient; several series of questions have been scattered broadcast, and the tabulation of the answers is a heavy business: the enormous mass of statistics from the fish-curing yards has been under tabulation, but is too much for the office even if there were no other duties; I have had to send out the clerks on independent tours of enquiry both to increase my store of facts and to accustom them to observational work. The F.C.11 monthly returns from the fish-curing yards number annually between 1,500 and 1,800; in many cases and seasons, they are crammed with figures relating to the places, periods, depths, distances at sea, quantities, stomach contents, prices (fresh and cured) of the catches of a great variety of fishes; these had been accumulating for some years, and are regularly coming in. If these could be tabulated, we should at once have—assuming their correctness, and in the main facts this may be assumed—a large body of necessary information as to the seasons and classes of fish, their movements, places of capture, weights caught and prices obtained. Tabulation has been accordingly attempted but the task requires a staff of tabulators of moderate attainments and pay, who will do nothing but tabulate; for individual fish, such as seer, I have obtained some information but the work is only begun.

10. I would therefore make the following proposals, viz., that Government should create a small bureau of fisheries, consisting of a Director, with a subordinate staff which should for the present consist of an assistant, two sub-assistants, four clerks and four peons. In my letter No. 88 (*c*) of this date, I have proposed that three students should be sent to study at the Imperial Fisheries Institute in Japan (see also paragraphs 216, etc., of my Japanese report); these men will form the earlier experts of the proposed bureau, but except so far as provided from my present office, they need not be brought at present on to the strength of the establishment.

11. The work in the immediate future will be (*a*) experimental, (*b*) observational, (*c*) compilatory, and (*d*) clerical. In the first three sections my assistant will be engaged as mentioned in my letter stating my programme for this year; he will experiment in the fresh-water hatcheries, he will go on tours of observation and enquiry, and he will compile all the matter available on fresh water fisheries; as the work develops he will take up other duties including those of supervision of all cultural operations and of instruction and suggestion to the public.

ORDER—No. 734, REVENUE, DATED 1ST APRIL 1907.

1. The Government accept generally Sir F. Nicholson's proposals as to the formation of a fishery bureau. They consider that the appointments he suggests are suitable and may be permanently created with effect from 1st April 1907, the pay of the assistant being fixed at Rs. 175—5—200 per mensem. The Government of India will accordingly be moved to sanction the creation from that date of the following appointments :—

One Assistant on a salary of Rs. 175–5–200 per mensem.

Two Sub-Assistants on a salary of Rs. 50–5-75 each per mensem.

One Clerk and Typist on a salary of Rs. 30 per mensem.

Three Clerks on a salary of Rs. 20 each per mensem.

Four Peons on a salary of Rs. 8 each per mensem.

2. His Excellency the Governor in Council has no doubt that it is highly desirable that Sir F. Nicholson should continue to direct the work of the Fishery Bureau. In order to afford him a more definite status in connection with this work, the Government propose that he should be styled Honorary Adviser for Fisheries to the Government of Madras. The Government of India will be moved to sanction the continuance of Sir F. Nicholson's deputation for a further period of two years from 1st July 1907.

ORDER—NO. 1682, REVENUE, DATED 3RD JULY 1907.

As the direction of the lines and the methods of investigation will continue to rest with Sir F. Nicholson during the two years of his prospective direction of fishery work, the Government consider that he should be styled "Honorary Director" instead of "Honorary Adviser."

Despatch—from the Government of India, Finance Department (Salaries, Establishments, etc.,—Minor Department.)
To—His Majesty's Secretary of State for India.
Dated—Simla, the 29th August 1907.

In continuation of the letter No. 41–12, dated the 30th May 1907, from our Secretary in the Department of Commerce and Industry, to the Under Secretary of State for India, we have the honour to forward a copy of a letter No. 1653, dated the 1st July 1907, from the Government of Madras, regarding the appointment of a Piscicultural Expert under Sir F. A. Nicholson, at present engaged in the investigation of the fishery industry of the Madras Presidency.

2. In view of the importance of the subject, the Government of Madras, at the instance of Sir F. A. Nicholson, have recommended in lieu of the assistant on Rs. 175–5–200 a month, the employment of a European expert with practical cultural experience who would be engaged, in the study of the inland waters of the Presidency, in experiments regarding the culture of carp and other fresh-water fish, and in the training of Indian students in pisciculture. They further propose, should the post be sanctioned, to appoint to it, on a five years' agreement, Mr. H. C. Wilson, who is engaged in an examination of the rivers and streams of the Nilgiris and who possesses the requisite qualifications. The pay suggested is Rs. 500–50–750 per mensem, with travelling and leave allowances under the rules applicable to officers of corresponding rank in Government service, but without exchange compensation allowance.

3. We recommend the proposal of the Madras Government for your sanction.

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Despatch—from His Majesty's Secretary of State for India.
To—His Excellency the Right Honourable the Governor-General of India in Council.
Dated—India Office, London, the 4th October 1907.

I have considered in Council the letter from Your Excellency's Government, dated 29th August 1907, No. 332 (Finance), recommending that a European piscicultural expert be appointed to assist Sir F. A. Nicholson in the investigation of the fishery industry of Madras

Presidency, and proposing that the appointment be offered to Mr. H. C. Wilson on a five years' agreement at the pay of Rs. 500–50–750 per mensem, with travelling and leave allowances under the rules applicable to officers of corresponding rank in Government service, but without exchange compensation allowance.

2. I sanction these proposals.

ORDER—No. 3035, REVENUE, DATED 11TH DECEMBER 1907.

The Right Honourable the Secretary of State for India having sanctioned the creation of the appointment of a Piscicultural Expert to assist Sir F. A. Nicholson in the investigation of the fishery industry in the Madras Presidency, for a term of five years on a salary of Rs. 500–50–750 per mensem with the travelling and leave allowances ordinarily admissible under the Civil Service Regulations and without exchange compensation allowance, and Mr. H. C. Wilson having been selected for the appointment with effect from 4th November 1907, Mr. Wilson will be directed to work under the orders of the Collector of the Nilgiris with head-quarters at Ootacamund until Sir F. A. Nicholson's return to India.*

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* On the expiry of the above 5 years' contract Mr. Wilson's appointment was, in 1913, made permanent and pensionable, with improved pay and other conditions. Mr. Wilson is therefore the permanent Piscicultural Expert in the Madras Fisheries Department.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., I.C.S., Honorary Director of Fisheries to the Government of Madras.
Dated—the 31st December 1907.

It will be observed that I have not carried out the programme sketched in my letter No. 88 (*b*), dated 28th February 1907, viz., of visiting Canada and Japan with the view of arranging for the training of students in the latter country. I had in June taken my passage thither but gave it up for considerations to be presently stated.

2. *New ideas and suggestions.*—In criticizing my Japanese report, Government objected to a Japanese training for Indian students on the score of the language difficulty, and desired me to ascertain whether similar training could not be obtained in Great Britain or America. On personal enquiry from officials and others, both in England and America, I found that there is nothing anywhere to correspond in any way with the general and technical training provided by Government in Japan ; the circumstances of all other countries are so entirely different that no such training institution, whether Government or private, is necessary or even desirable ; *catching* including the whole art of sailing a ship and using the nets with the skill and knowledge bred of long practice, is only learnt by long apprenticeship at sea to the various branches of the art ; *curing* in all methods is learnt solely in the curing yards and factories, and there is no technological school for its scientific study ; *pisciculture* is on a somewhat different footing since in America there is a great deal of pisciculture carried out by various Government agencies ; so also in Great Britain, but solely by private persons and for the culture only of trout.

3. The question then arose as to the training of Indians in the three branches ; would the above circumstances compel or render desirable a Japanese training notwithstanding the language difficulty ?

4. As regards *catching*, here I must at once admit that the idea of my Japanese note, viz., to send students to the Japan Fishery Institute for training in this branch, was wholly an error ; apart from the language difficulty, there is the impossibility of transforming delicate Indian College students into sailing masters and deep-sea fishermen. In every country, Japan not excepted, deep-sea

fishing is carried out by men whose sole business it is and who pass their lives in it from boyhood to old age; they are invariably robust, hardy, seafaring men whose lives are one long toil amidst great hardships, climatic and otherwise, and dangers. In Great Britain and America the fishermen, other than the inshore men, not only go habitually with their lives in their hands, but endure incredible hardships; for much of the year, the mere work and discomfort of stormy weather is most serious, but a considerable part of the best catching season (autumn to spring) is so rigorous that none but the most hardy can stand the exposure; it is common for decks and rigging to be a mass of ice with the thermometer far below freezing point, and icy seas continually breaking over the boats; only the hardiest men born in the climate and inured to hardship can survive. In Japan the same is the experience (see my note, paragraph 7); the storms are most serious and severe; except in the extreme south the cold in winter is intense, while the boats are far less suited to the exposure than the staunch British and American smacks or steamboats; the Japanese can only stand it, when they do, by their extraordinary powers of endurance and resistance to exposure, as shown, for example, in the late war.

5. But if in Great Britain, America or Japan a man intends to become an experienced sailing master and deep-sea fisherman, he *must* go through a long course of these risks and hardships, entering the service while young and gradually working up to the higher posts of master and skipper. The young men who, in Japan, attend the Institute are of this sturdy fishermen class, and the training in the Institute is merely supplementary to ordinary practice; just as in England, etc., young men of the artisan class attend technical institutes to gain a more complete and scientific grounding in the principles of their art. The catching of sea fish cannot be taught on dry land; the only school is at sea; hence, in Japan the fishermen class, compulsorily educated as all Japanese are, go for a while to a training Institute and are educated in the principles of their art, very largely at sea, while those who are to take a higher place, extend their sea training to long deep-sea voyages to Korea, Saghalien, Siberia, etc., like ordinary fishermen.

6. Now in India it is out of the question to send boys or men of the fishermen class for training abroad ; they are among the most ignorant, prejudiced, and boorish of the lower castes, though individually fine men and well versed in their ancient methods ; a few minutes with men on the Madras beach will show this. On the other hand, in addition to the caste difficulty, the educated men of our schools and colleges are delicate, wholly unused to and disliking manual labour, quite unfit for continuous exposure to storms and wintry cold at sea, the very last men in the world to send for deep-sea training in European or Japanese waters ; a week of British or Japanese work, except in fair weather, would, literally, kill them. I should have foreseen this, but it came home to me in observing the men and conditions of British deep-sea life and hearing of them at first hand from competent observers. Under these circumstances, I abandoned, as impracticable, the idea of training Indian students abroad as future deep-sea fishing experts.

7. Moreover, except *possibly* for one experimental trawler-drifter, I hope to work from the bottom, by very gradually improving local and indigenous boats and methods, so that we shall not at once want highly trained deep-sea experts, capable of taking a trawling fleet to sea, so much has a body of local fishermen working and gradually developing under the suggestions and help of one thorough expert, aided by crews or instructors drawn from more advanced localities which I have in mind. Ireland taught me this amongst other lessons, and I shall shortly propose adaptations of Irish methods ; in north-west Ireland they obtain Scottish Superintendents, and work a class of newly introduced large sea boats by local crews who are stiffened and taught by one or two instructors (superior fishermen) drawn either from Scotland or from more advanced part (Arklow) of Ireland, or even by special crews brought from such parts. Here I shall propose an European expert to be stationed in Madras itself, who will *inter alia* assist local men to understand and work improved (Ratnagiri) boats with the aid of (Ratnagiri) men who may be permanently engaged for the purpose ; in Bombay last week I found that they are accustomed to work large fishing boats, up to 30 tons, at more than 30 miles from shore.

8. There is, however, no reason why young men properly selected as to physique, temperament, and other qualifications should not be trained in Indian waters as deep-sea fishing experts ; lads or young men can easily serve as apprentices on sea-going boats, for there are no such hardships here as in European or Japanese seas ; climate and weather are favourable throughout the fishing seasons, and the risks are slight. For this purpose graduates are not necessary, but merely strong, intelligent lads ready to take up a sea-going life of a simple, easy, and near-home character, and to learn the methods of handling new classes of boats and nets and of handling the fish caught.

My detailed proposals will be sent in shortly. I now merely explain my reason for not going to Japan, my change of views, and my general suggestions.

9. In another letter dealing with the Indian Fisheries Company at Cochin and its work, I am showing that both in the catching and curing branches this Company's operations will provide a large experimental station where the very experiments which we contemplate will be carried out on a great scale and Indians will be trained in all sea-going and preserving methods as well as in matters not covered by our present programme, such as the preparation of fish oil and fish manure. This is another reason for going slow in sending Indians abroad for training in fish catching.

10. Then as regards *curing*. I have mentioned just above that the Indian Fisheries Company will conduct operations not only in the catching but in the curing branch ; the object is to send large quantities of wholesome fish up-country and this can only be done at a cheap rate by various curing and canning processes. We should not, however, rely wholly on this Company's efforts in curing any more than in catching, and I still propose to open an experimental station ; not on the West-Coast however, but in Madras for reasons to be given below. For the teaching of canning and special methods of treating fish I propose to obtain an expert of the foreman or rising foreman grade from one of the English firms whose works I have visited, and to attempt a thorough development of this industry. But *ordinary* curing is not a mysterious art ; it exists already on our coasts, and what is needed are improvements and

developments which are either simple matters of speed, cleanliness, and common sense, or are reforms and advances resulting from applied science, or are introductions of simple methods elsewhere in vogue, such as smoking and wet pickling, the use of vinegar (as in Bombay), etc. I am now personally able and ready to direct the conduct of experiment in these improvements; one or two Sub-Asssistants selected for particular qualifications will be needed and a few indigenous curers of the better and more intelligent sort; with this material good progress may be expected. It has been suggested to me by Lord Ampthill that skilled Japanese instructors might be obtained at a moderate cost for our technical work, and it is quite possible that in the curing department this might become advisable; the point will be hereafter discussed with other details in a separate report on the experimental station.

11. *The experimental station.*—As elsewhere noted, the Indian Fisheries Company is starting large works, partly of an experimental nature, at Cochin on the West Coast, and its operations will extend to other places than Cochin; these operations are intended to and, it is hoped, will cover experiments in all the items included under catching and curing. The conditions of the West Coast from Cochin to Mangalore are all similar both in the nature and depth of the sea, the breadth of the comparatively shallow (trawlable) area, the classes and seasons of fish produced, the classes of persons engaged, the implements used, and the communications available. Hence, experiments in Cochin will be as instructive to the whole West Coast as experiments at Tellicherry, and since the experiments have actually begun and should, by reason of abundance of funds and experts, be more rapidly and thoroughly conducted than any which Government could at once undertake, I consider that the proposed Government experimental station at Tellicherry should be transferred to the East Coast.

The locality which I would now propose is Madras, or the neighbourhood not further north than Ennore or south than the Adayar. Apart from the reasons given above for transfer from Tellicherry, Madras is indicated as the best site for a station; it will probably be the head-quarters of the Fisheries administration; scientific talent and assistance—engineering, mechanical, chemical,

etc.—can always be drawn upon ; the results of successful experiments will be noticed by competent observers and readily disseminated by the press or otherwise ; the city is a centre of industrial and business enterprise and capital which will be able to adopt and push successful fishery and curing methods ; there is a harbour in which any experimental vessels, such as steam trawlers, can shelter ; hardy and expert fishermen are numerous, and the local agencies for placing fish on the market are experienced and probably eager to adopt ascertained improvements, especially in methods of bringing fish fresh and expediting its transit ; the local market for fresh fish is unlimited, while, as the head-quarters of two main railways, experiments in the consignment of fresh fish to Bangalore and other distant markets can readily be undertaken ; as a city where custom is less binding than in the districts, the market for new products such as pickled or smoked fish, could be tested and the taste for such goods diffused. I, therefore, suggest Madras, and will shortly examine the neighbourhood in view to finding a good site ; it is possible, however, that a sub-station for canning will have to be started in a locality where sardine are more abundant.

12. The objects to be kept in view are those mentioned in my Japanese note, paragraphs 186 to 194. In the matter of *catching* ; it is a question for discussion whether Government will plunge direct into large enterprise such as that of fitting out a trawler-drifter for a quantitative exploration of the waters outside of Madras and for the introduction at once of the most modern methods in view to assist private enterprise to undertake such methods. On the one hand, we know nothing of the possible productivity of those waters, nor is it probable, at present, that private enterprise will risk capital in a commercial venture upon modern lines without some idea of the chances of success. On the other hand, is it not better *not* to attempt too much or take too large strides at first ? will it not be well to work slowly upwards through the small sailing boat and indigenous fishermen by steady evolution rather than to attempt or even suggest a revolution in fishery methods by even the experimental introduction of the latest western apparatus? It is all very well for progressive, wealthy, highly educated nationalities as in Canda, New Zealand, the

Cape, etc., to start a *new* industry by importing and working steam trawlers; there is no reason why an up-to-date nationality should not begin at once in the newest fashion. But in Madras we have a vast existing industry worked for centuries in the most primitive fashion by a large population of ignorant but industrious men, and we cannot ignore them and their interests, welfare, and industrial conditions; we cannot jump at once from the catamaran to the steam trawler any more than we can from the mamoty to the steam plough. Just as a steam plough to be successful would involve the upset of the small peasant and require the introduction of the capitalist landlord or farmer, so the immediate introduction of the modern steam trawler—if, indeed, it were possible—would mean a revolution of the fishery system by bringing on the capitalist and reducing the fisherman to a paid hand. This may come, but, if so, it should be only by a gradual industrial evolution, and Government should not force it on even by suggestion. Even in progressive Japan no such attempt is being made (see my report), and in Ireland the method is purely gradual and evolutionary.

As mentioned above, I propose rather to engage one or two Bombay boats with their crews complete who will work the waters near Madras, not at present exploited by the catamarans, and who will teach local men the use of sailing boats and new methods. Details will follow; at present I merely indicate my preference for slow evolutionary methods and the particular line based on Irish methods which I hope to take.

13. But *preservation* will be the chief object of immediate experimental work, viz., proper preservation on board and for fresh fish as far as the market, and for cured fish throughout the curing process; untainted, wholesome fish will be the aim rather than a larger supply of the present quantities. Better preservation by the proper methods of handling on board will, however, increase the catches which are now limited not merely by the smallness of the boats, but by the inability of ignorance to delay the access of taint; better conditions of cleanliness, the keeping of the fish alive, the gutting and cleaning of it on board, the use of certain innocuous preservatives, etc., would greatly improve the keeping power of the produce, so that catching will automatically increase with

the development of proper preservation on the boats. After that the supply of wholesome food depends entirely on methods of preservation, and the unanimous opinion of all experts at home with whom I discussed tropical difficulties, was that preservation—preservative methods—are the crux of the problem. I have accordingly studied this question with some minuteness and have decided upon a variety of definite experiments for the station both in ordinary and in special preservative methods; ordinary, embracing the more varied use of salt as in pickling, the use of smoke, vinegar, etc., better methods of drying, etc., together with a small refrigerating plant chiefly for lowering the working temperature in certain cases; special, in the application of certain simple and innocuous preservatives and methods which, though not novel to science or always to fish curing, are novel in general application because in western countries they are unnecessary by reason of climate, of the universality of cheap ice and refrigeration, of the general use of canning, and of the larger use of cheap salt, smoke, etc.; in India they are, of course, entirely novel by reason of the general ignorance of any preservatives other than salt and solar heat, and, in a few places, of vinegar or other weak acid such as tamarind juice and peppers.

14. *The appointment of a Director and Superintendent.*—After observing the work, methods, and staff of the Congested Districts Board, Ireland, and comparing those of Japan, I feel the necessity for a proper directing and supervising as well as technical staff.

15. Omitting at present the technical men, we need, in the first place, a Commissioner or Director who should be an officer of wide administrative experience, accustomed to Indian needs, habits, social conditions, prejudices, conflicting interests, etc., but possessing also a good knowledge of fishery work and results throughout the world; this officer would be the *arbiter agendi*, to control and sanction the general policy and lines of action in all the branches of fishery work, marine and inland, to co-ordinate, regulate, criticize work, to promulgate successes, to negotiate with other departments, railways, business firms, etc.: he should not, however, interfere with details. The Commissioner for Agriculture in the Board would probably be the most suitable authority, if possessing fishery knowledge.

16. Secondly, we need two Directors (or Superintendents or Deputy or Assistant Directors) one for marine and one for inland waters ; these must be fishery experts who will deal with and supervise the details of work, will conduct the necessary enquiries, will translate into definite methods and experiments the policy and lines of action sanctioned by the Commissioner, and will supervise the staff. Government have already appointed Mr. Wilson as Piscicultural Expert, but I take it that this designation hardly expresses his full duties, since he will necessarily be occupied in biological, economic, and local investigations as a necessary preliminary to, or concomitant of, piscicultural work, and in such conservational work as enquiries may show to be possible. For the present then, I take it that Mr. Wilson will be the Deputy Director for freshwater work.

17. For directing marine work there will be more difficulty in obtaining a really competent officer ; except perhaps, in Japan, it is very difficult to find an all-round man acquainted on the economic or industrial side with the fishing business in its several branches of catching, curing, and distribution ; in Great Britain this highly-developed business is so split up that one man seldom combines a knowledge of various branches ; e.g., even in the catching branch, the drifting skipper cannot trawl and knows nothing of long lining ; the curing trade again is separate from the catching branch and, except in certain items, separate in the various classes of curing ; the salesman again is not necessarily an expert in anything except the distribution of the fish. Again, there is a sharp line between the scientific and the industrial lines, and while scientific men can somewhat easily be obtained, they are usually more scientific than industrial, and for our present Indian purposes we want men who are, in the first place, industrial experts, yet, in the second place, have such a knowledge of the science—biological, chemical, hygienic, etc.—which underlies practice, that they are not mere rule-of-thumb men who know and can teach only what they have learned empirically.

18. A concrete case will show the difficulty ; in Ireland the Congested Districts Board has worked its fisheries in a most prudent and enlightened way for sixteen years with Scotch Superintendents and Instructors in several branches. Yet, when in 1907 the Board required a Chief

Superintendent for their fishery operations, there was not a man in the department who could be put in, and candidates had to be invited by advertisement ; the candidate selected is said to be exceptionally well qualified (" very few have the general knowledge of so many different branches of the fish trade that he has " says a notice in the " Fish Trades Gazette "), having been cooper, fishery clerk, salesman, and manager to a trading Company, etc., and it is hoped that he will fill the position. The fact is that the post is a most difficult one to fill requiring not only much varied yet highly accurate knowledge, but many other qualities. In Ireland the Congested Districts Board enjoys the extraordinary good fortune of having the Rev. W. S. Green, C.B., as its adviser and practical head, an officer who, a born fisherman, is deeply versed in both science and practice, can skipper a steam trawler on a three months' voyage, take his place in the laboratory, organize and direct the whole series of difficult operations involved in developing a backward or even non-existent industry from the building of the boats, supplying the crews with such boats on reasonable terms, and teaching the crews, down to marketing the fresh or cured fish, and so forth. Hence the personal qualifications of the Superintendent are less material in Ireland than they will be in Madras where, since a Commissioner in the Board cannot possibly have the unusual qualifications of Mr. Green, it will be necessary to try and obtain such qualifications in the marine Superintendent. The difficulty will be more clearly brought out when I discuss my plans for immediate work, based as they will partly be on proved Irish methods. I hope, however, that by advertisement we may obtain a man who will unite comparative youth with large experience, wide and accurate knowledge, scientific and industrial, with an open and adaptive mind, thoroughly up to date in modern methods yet ready to go slow in applying his knowledge to a backward and poor community.*

19. The mere industrial experts—such as foremen canners, curers, etc.—will be mentioned in my detailed letter on the experimental station and its needs.

* By a fortunate concurrence of circumstances the services of Mr. James Hornell, F.L.S., became available in the middle of 1908, and he was appointed as Marine Assistant temporarily in 1908, and more permanently in 1909, when he also became Superintendent of Pearl and Chank fisheries.

Letter—from Sir F.A. NICHOLSON, K.C.I.E., I.C.S., Honorary Director of Fisheries to the Government of Madras.
Dated—the 31st December 1907.

In my letter No. 230, dated the 31st December 1907, I have mentioned the "Indian Fisheries Company" of London; this is already a going concern, at present in the Syndicate and experimental stage, in actual operation on the West Coast. I have frequently interviewed the London firm which is the active centre of this concern, and is a very pushing and prosperous firm, the head of which is connected with enterprise all over the world; their declared intention is the development of the fish trade in all branches, for Indian needs first, and, failing an Indian demand, for export purposes. They have begun with an obvious article and opening, viz., the purchase of dried oil sardines for export as manure, but this is merely a beginning; it is intended to revive the fish oil industry and to push on Indian trade in oil and manure for which experts and plant have already been sent out; to develop deep sea catching methods by the most modern plant, which, I understand, is under order; the fresh fish trade is expressly mentioned as an attractive development, and the head of the firm when out here at the beginning of the year sounded the railway authorities on the subject of refrigerating cars, rates, etc.; the canning and cured fish business which they have in view will, to my mind, probably precede the fresh fish trade. It is intended, if experiments and first attempts are successful, to develop the syndicate into a company with a large capital, and to push the business in all branches. I may add that during my voyage home I became acquainted with a Calcutta merchant interested in an Indian business for which fish oil is especially necessary, and on hearing of his needs, running into many hundreds of tons annually, I placed him in communication with the Indian Fisheries Company, and am told that the result will probably be a large immediate business.

2. I mention this enterprise because it will explain why I am not now keen on a large Government development, in the way of experiment, on the West Coast; if this firm carries out its intentions—of which I have no doubt, as the beginnings have, I believe, been very

lucrative—the whole work of an experimental station on the largest scale will be carried out in thorough business fashion, with abundant funds, the best experts, and complete continuity; Government intervention would therefore be unnecessary; the company will ascertain for Government and for the public whether trawling, purse-netting, etc., are possible; whether, as I believe, the shoals of fish can be found and followed well out at sea when they fail to visit the shore; whether the West Coast is as prolific over its average breadth of, say, 40 miles of shallow sea, *i.e.*, within the 100-fathom limit, as it is within the five-mile area at present worked; whether fish can be brought to shore and placed on the market in good and wholesome condition, and so forth. I regret that it is not a Swadeshi business, but it fulfils my prediction (Japanese note, paragraph 231) that European enterprise will take the cream of the business if Indians hesitate, and the enterprise will undoubtedly be carried out in a way which should induce imitation. There will, however, be plenty of room for less highly developed operations; one or two steamers cannot work 15,000 square miles of sea, and there will be plenty of room for small sailing smacks worked by independent fishermen or groups.

Moreover, the Company's vessels and works will not only provide object lessons, but will necessarily train men in all branches of deep-sea fishing, and in the subsequent handling of fish, whether fresh or preserved in various ways, and fish products. For though Europeans will at first *supervise* in all branches, whether as skippers, engineers, curing masters, foremen, etc., the mass of work-people will necessarily be Indian, and as intelligent experience grows and competition requires the cutting down of expenses, Indians will gradually be trained to take up all but the very topmost places, and will thus provide that body of industrial experts which it is the aim of Government to provide in this as in other industries.*

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* This Company did not, after all, materialise in the manner expected; the Company devoted its attention only to fish oil and fish guano, and is now (1915) represented by a single oil and guano factory at Cochin. Its failure to develop as expected reacted unfavourably on the Fisheries Department which, as shown in the text, awaited that development, and, partly in the interests of the Company, temporarily abandoned operations on the West Coast.

Similar disappointments in the matter of fish-curing and fish-canning were experienced on two other occasions, and materially affected departmental work.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., I.C.S., Honorary Director of Fisheries to the Government of Madras.

Dated—the 5th May 1908.

I have the honour to make proposals for a Marine Fishery Experimental station. They involve, however, decisions on large questions of policy and cover much of the ground of a general report; hence a considerable degree of detail. The objects of the proposed station are to ascertain facts, especially the proper methods of catching and placing on the market a greater abundance of marine products at once wholesome, cheap, and acceptable, and to disseminate such facts by teaching and by demonstration both on the spot, in other yards, and in the markets; in all operations it will be especially sought to enlist public interest and, where possible, actual co-operation, as will presently be shown. This letter is an expansion, based on fuller and more detailed knowledge, of paragraphs 186 to 194 of my note on Japanese Fisheries. It is not concerned with freshwater fisheries.

The work will involve the expenditure of time, money, and labour, sometimes perhaps unsuccessfully or unremuneratively, and an investment in plant which may subsequently be found unsuitable or too expensive for general adoption; this is necessarily the case in pioneer movements such as Government is undertaking. But I have proposed *nothing* which is not in successful practice elsewhere in the same industry or for similar purposes, and should, in some cases, success be attained by methods or with plant seemingly too costly for ordinary *individual* use, it will be sought not only to minimize expense by studying how to simplify plant and methods, but also to render improved plant possible by stimulating co-operation or joint enterprise, and by the extension to fishermen and curers of the loans systems at present confined to agriculturists.

2. The points for decision are—

(*a*) the lines on which experimental development shall proceed (paragraphs 3 to 45);

(*b*) the position of the station (paragraph 46);

(*c*) the classes of experiment proposed and character of the plant necessary (paragraphs 47 to 68);

(*d*) the required staff (paragraphs 69 to 72); and
(*e*) the approximate cost (paragraphs 73 and 74).

In paragraph 75 I have abstracted my several proposals.

THE LINES ON WHICH EXPERIMENTAL DEVELOPMENT SHALL PROCEED.

3. Two points will be steadily kept in view in the present attempt to develop Madras marine fisheries. The first is that the scene and scope of our work will chiefly be in the deep sea, *i.e.*, in the area outside of the three-mile or even the five-mile limit; I do not propose to interfere, except in matters of detail, with that inshore area, but to create a deep-sea fishery anywhere outside of that limit.

The second and most important is that it is the food of the masses which is our chief concern, the food of those vastly preponderating numbers (75 to 90 per cent. of the population) who will always eat animal food if they can get it, but can in no case afford more than 2 annas or so per pound even for good, solid nutriment, and even less for ordinary fish or flesh; I am less concerned with the 4 to 6 anna folk who live in definite centres such as Madras and who should be provided for by ordinary trade organizations (of which there are beginnings in Madras and Calicut) operating with modern plant for the supply of good fresh fish. The latter will not be neglected, but the prime necessity, the first and chief object of investigation and effort, will be the supply in large quantities of cheap food preserved in a variety of ways and of undeniable wholesomeness to the masses in the interior; cheap and good fish food and cheap and good fish manure for the million. Hence it is the sailing boat and the curing yard rather than the steam trawler and the refrigerating car which will primarily engage attention.

There is a vague popular idea that development means "steam trawlers"; that there is an illimitable sea harvest waiting outside only needing to be gathered in by modern plant; that the one necessity is to sweep in the greatest possible quantity of fish and throw it upon an avid market, and that this can be done by starting steam trawlers, the first being, of course, a Government experiment the success of which is to herald the modern

steam fleet. As already mentioned in my Japanese note and elsewhere, my own idea of Madras needs and methods is, on the contrary, that we do not at present need or want steam, save for particular cases; that to jump from the catamaran to the steamer is impossible and unwise if possible, and that our true method is to proceed by the ordinary and historical process of slow development; revolutionary methods, here as elsewhere, are a mistake. We want to develop, *gradatim et pari passu*, the fisher folk, the fishing industry, and the fishing trade by methods which will not necessarily reduce the fisher folk to hired labourers under capitalists (European or other); which will gradually catch more fish and bring such fish in a proper condition to market; which will gradually create a demand for a better article than that now produced and consumed; and which will gradually develop an indigenous organization able to place that article cheaply and through ordinary trade lines on the inland market. We cannot do this with a rush; if steamers caught large masses of fish it is a question if it could be done with profit except for the foreign manure trade; it is still more doubtful if it could be placed as safe *edible* goods on the inland market at a price which the Indian in general can pay. The whole process of catching, preserving, and distributing must evolve together and with equal steps. Even Japan has proceeded to develop its fishing industry on these lines, though it is not hampered by a tropical climate which is the grand difficulty in India and which militates strongly against the sudden introduction of methods found useful and necessary in Europe.

Yet while endeavouring to evolve rather than to revolutionize, it will not be forgotten that even such progress necessarily implies new expenses and new methods such, for instance, as that of combination among fishermen, curers, and small capitalists; so far from meaning adherence to individualism it probably requires combination either co-operatively (*en mutualité*) or joint stock. For some of the developments will require the use of capital—not necessarily large—as for improved boats and nets, drying and salting plant, smoke houses, etc. Mechanical and other appliances are not ruled out but actually demanded by a developing industry, so that the experimental station will not exclude but include such

developments, aiming, however, always at simplicity and again simplicity.

By enlisting public and private co-operation it is sought not merely to lighten the burden of experimenting and to diffuse results but so to stimulate practical public interest that the station may be the active agent in forming a general Fishery Society such as that described in paragraphs 14 to 18 of my Japanese note; there must be some visible action and results, some *point d'appui* on which to base a society for practical work in the present condition of public opinion on such a matter as the catching, curing, and eating of fish in which the most progressive intellects and intelligence of the country are, of course, uninterested. I consider it better to attempt the formation of societies and associations after the achievement of some practical success rather than to start a mere academic debating society. The same argument applies in still stronger fashion, to the foundation of the still more practical business societies and Chambers described in paragraphs 104 to 122 of my Japanese note. The station will be made not merely a place of experiment but a centre for the instruction and stimulation of public and private enterprise.

4. In paragraphs 5 to 45 I proceed, under this head, to indicate the probable lines of immediate policy and of immediate practical action, especially at the experimental station, by showing—

(1) that steam, especially steam trawlers, are a very recent Western development, necessitated or made possible by the conditions of the Western fish trade such as the depletion of the home waters leading to distant voyages in rough and wintry seas, a strong effective demand, high prices, an elaborate organization, a wealthy distributing trade, rapid communications on land, cheap coal and ice, etc.;

(2) that even in the West the sailer holds its own where fishing grounds are comparatively near at hand, and coal comparatively dear;

(3) that in Madras Presidency waters the conditions demanding or permitting steam for actual catching do not in general exist, and that sailers will fill the need; steam or power boats in catching are only needed for special purposes such as the supply of high-priced goods and, possibly, fish for canning;

(4) that improved sailers to supplement the present fishing boats are, however, an essential in the development of Madras fisheries, since the catamaran and dug-out are inshore boats which though costing much in time and labour are too weak and comfortless to exploit any but the margins of our coastal fishing grounds and cannot fulfil the *essential* condition of preserving the fish from taint in transit to shore from any but short distances ;

(5) that larger boats would readily exploit the fishing grounds (within 100 fathoms), seeing that these grounds lie alongside the 1,650 miles of coast (exclusive of indentations) in a comparatively narrow belt nowhere exceeding 60 or 70 miles of easy sea and averaging less than 20 on the East Coast and less than 40 on the West Coast, and that such boats would render possible modern methods such as the proper treatment and cleaning of the fish at sea, the use of preservative methods, the keeping of fish alive in live wells to shore, and so forth, by which the dangers at present existing from tainted goods may be largely obviated ;

(6) that the swift carrier is, if not an essential, a most powerful instrument in the production and placing on the market of sound edible goods at moderate price ;

(7) that the use of preservatives and preservative methods is essential not only to development but to public health ; with an indication of the methods, including canning, which are at present open ;

(8) that these reforms, if successful, will develop—

(*a*) the high class markets of the interior,

(*b*) the cheap markets of the people, while removing serious hygienic dangers ;

(9) that these reforms being comparatively simple and cheap, can and will be carried out by indigenous action both in the industry and in the distributing trade, Indian firms and individuals being already engaged in the trade, anxious for developments, and ready both to co-operate with Government in experimenting and to adopt the developments proved by experiment ;

(10) that by developing on these lines the existing large fisher population will be as little as possible disturbed either in social or industrial status and will be brought into the line of progress by gradual steps ;

(11) that marine cultural operations are not at present advisable except in the matter of shell-fish, especially oysters, in the various backwaters ;

(12) that with one small exception restrictive rules are not at present suggested or needed, but that close observation is necessary over a series of years on both coasts (*a*) to ascertain for the fishermen the character of the deeper waters and the movements of fish especially of shoalers, and (*b*) to ascertain spawning places and seasons in view to decide whether any restrictive rules may become necessary ; this observation to be carried out at sea, at experimental stations, and at fish-curing yards.

5. *Steam is of recent introduction in Europe and generally unnecessary at present in Madras waters.*—Even in Great Britain steam is of the most recent introduction ; prior to 1880 the whole of the then vast and highly organized industry was conducted by sailing craft which in turn had steadily evolved by gradual development ; sixty years ago in Scotland most of the boats were small and open ; they were then enlarged and decked, and these in turn some 25 years ago began to give place to the steamer. It was the enormous effective demand for high class fresh fish caused by rapid communication on a vast network of railways, coupled with immense enterprise, large capital, thorough organization, abundance of cheap ice, etc., which led at first to the development of large sailing craft working the most approved and deadly implement such as the 50-foot beam trawl, the drift net miles in length, the long lines with 7,000 hooks, and by consequence, to such comparative depletion of the nearer waters and to such competition that the fishermen were forced to go further and further afield ; cheap coal and ice and a rise in the prices of fish then made steamers and long voyages possible, and to-day the steam fishing boat capable of and habituated to voyages of a thousand miles and able to weather the storms of any sea, are leading features of the British industry. But even in England steam is by no means universal ; wherever the fishing grounds are comparatively near and coal comparatively dear, the sailer holds its own ; the Brixham, Ramsgate, and other Channel or near-home trawlers are all sailers, as are the French luggers which one meets off Ushant, the Scilly Isles, etc., and so in many other places ;

it is a question of profit, and the lugger with few working expenses can very well compete with the steamer when the grounds lie near home; Ramsgate smacks fish the nearer portions of the North Sea, say within 100 miles of port, as well as the Channel, and Brixham trawlers for much of the year fish the grounds between Portland and the Lizard within 30 miles of land. So in America the finest boats, e.g., those on the Newfoundland banks, are all sailers; in Japan steam has hardly been introduced at all even for boats which go over to Korea and the Siberian coasts (*cf.* paragraph 94 of my Japanese note); it is the *sailer*, and very often the comparatively small boat, which brings in the immense sea harvest of Japan. It is a mistake therefore both historical and industrial, to consider the steamer as the immediate sequence of the small boat, or even to think of it as a necessity at all, except when the fishing grounds are distant and seas dangerous, speed obligatory, and prices high.

6. Now on the Madras coasts we have no single circumstance which, in general, favours or renders necessary the steamer as a catcher; economic and social expediency as well as industrial history indicate the sailer, and that not a big one, as the *next* stage of development.

First, Madras (the Presidency) is in the catamaran stage industrially, both as regards boats, implements, men, wealth, knowledge, enterprise, and the distributing trade;

Secondly, its fishermen cannot afford steamers or even big sailers;

Thirdly, prices, except, perhaps, in special cases, will not yield a profit after deducting the cost of coal, ice, machinery, the wages of expert crews and engineers, the interest on capital, the heavy depreciation on the steamers, etc.;

Fourthly, the independent fishermen would become mere labourers on the advent of the rich company or capitalist;

Fifthly, the fishing grounds are at the very doors of the fishermen and nowhere else, while the grounds themselves are comparatively restricted in breadth;

Sixthly, the weather and sea render steam generally unnecessary;

Seventhly, there are few harbours for the accommodation and repair of steamers;

Eighthly, steam in boats for catching is more important for trawlers than for other classes of boat (drifters and liners) as they require great power to drag immense nets at fair speed irrespective of wind and current; in Madras waters it is probable that bottom fish, which alone the trawler can catch, are in the great minority as compared with mid-water and surface fish.

As regards the sixth point it is to be remembered that not only is the climate warm so that exposure in good sailing boats causes little hardship, but that the weather is certain in an extraordinary degree, the winds and currents are well known and steady, varying according to season with the greatest regularity, the zones and periods of cyclonic storms are fixed and almost immutable while the signs and directions of their approach are well known, and the stormy monsoon seasons are, roundly speaking, regular in date and duration. So comparatively regular is the weather that for long periods together the fisherman can count on absolutely fine and equable weather, on going out with a land breeze in the morning and returning with the sea breeze in the evening. In a word the weather and sea conditions are as different from those of Great Britain, Japan, etc., as can well be imagined and are wholly favourable for sailing fishing craft.

7. *Larger boats are, however, essential.*—While, however, I see no present reason for the steamer as against the sailer as a catcher, I see very strong reasons for improved sailers, not indeed to replace but to supplement by deep sea work the inshore catamaran or canoe. I will mention briefly and broadly the present characteristics of coast fishing. On the east coast the catamaran or a variant as at Vizagapatam, is the general boat, as it is readily taken through the surf, is quite unsinkable, and when landed is taken apart and carried piecemeal up the beach; the masula or surf boat is solely used for shore seining. The catamaran, alone, in pairs, or in groups, uses various nets and lines, but is hampered by its small accommodation for men, nets, lines and fish, its absence of depth and capacity, its comparatively poor sailing and hauling powers, and the impossibility of

staying out many hours owing to exposure and inability to take a food supply ; obviously also it is impossible to deal with the fish either by proper storage, or by the use of salt or ice. In certain parts, as at Masulipatam, excellent fishing "dinghies" built of teak are in use, and in Palk's Straits, especially near Point Calimere, boats of considerable size are in use as carriers ; the Kilakarai and other pearling boats of the Manaar Straits are also well known. The Masulipatam dinghy can and does carry a respectable length of light cotton drift net which may aggregate half a mile in nominal or one-third in short length ; this, though exceptional, helps to prove the case for the general use of proper boats. On the extreme south, as at Tuticorin, the Ceylon boats, usually outriggers and splendid sailers, regularly come over in the cold weather for seer, but so far have found no imitators. On the West Coast the canoe or dug-out is universal ; this very narrow and crank boat being chiefly a row-boat requires a large crew and gives poor accommodation for nets and little room even to men ; its sailing power is slight and sails often non-existent ; obviously such boats are badly unsuitable for real deep sea work. The exception on this coast is a notable one, viz., the so-called Ratnagiri boats, comparatively large (6 to 10 tons) sailing boats from the Bombay Coast, which come down for the cold weather sea fishing ; these regularly come as far south as Tellicherry, but so far have met with no local imitators, though they are good sea boats and sailers, make the long voyage from the Bombay Coast, and could stay out at sea for days together, if properly provided.

8. These inefficient boats do the whole fishing of our coasts ; some fish by night, some by day, but in few cases does the stay at sea exceed 9 or 10 hours and the distance from land 5 or 6 miles for the following reasons :—

(*a*) food and water cannot conveniently be taken, especially on the catamaran ;

(*b*) the exposure and confinement in catamaran and dug-out cannot long be borne ;

(*c*) much of the work has to be done by rowing or paddling ;

(*d*) in this climate fish can nowhere and at no season remain in good condition for more than a very few hours after death ; and

(*e*) no cheap or simple methods are known or, at least, practised for the proper treatment or preservation of the fish from taint.

9. The results of this universal use of small boats are—

(*a*) the non-exploitation except in a small degree of any but inshore waters, i.e., waters within 5 miles of land, with at the same time an undue loss of time in going to and from the fishing grounds, and an undue cost in labour ;

(*b*) the use only of comparatively small and weak catching apparatus, whether nets or lines ;

(*c*) a considerable amount of actual taint or, at best, several hours of progress towards that condition, except where fish are caught in the shore seine or close inshore.

10. *Insufficient exploitation of the fishing grounds, etc.*—The fishing grounds of the Madras Presidency coast are peculiar ; on both coasts the sea-bed shelves fairly gradually from the shore to about the 100-fathom line which lies at from 10 to 70 miles from land ; from about that line it falls very precipitously, viz., to 1,000 fathoms and more within a very few miles ; e.g., near Madras the depths at 10, 20, 30 and 40 miles out are about 25, 100, 800 and 1,900 fathoms respectively ; outside Cochin the depths at 10, 30, 35 and 50 miles are 15, 50, 120 and 1,000 respectively. Of the fish capacity of the deep sea beyond 100 fathoms we know nothing, and it may be neglected at present as a practical fishing ground, though kept under observation as a source of fish, till the waters within 100 fathoms, which I designate as the fishing grounds, are properly exploited ; I use this depth as a convenient limit since it is practically the limit of trawling though by no means of drifting or lining.

11. These fishing grounds, then, vary in width from 10 to 70 miles, the average on the East Coast being just 19 miles or half that of the West Coast where the belt averages 38 miles ; roughly, the 1,200 miles of belt from Puri to Cape Comorin embraces an area of about 23,000 square miles, and the belt of 450 miles from Cape Comorin to Kundapur comprises about 17,000 square miles ; altogether there are about 40,000 square nautical miles of good fishing ground, nearly the whole of which presents few obstacles to any class of fishing, whether trawling, drifting, seining, or lining. The mere fact that

this comparatively regular and easily-fished belt lies for the whole distance absolutely alongside of the coast, so that its outside verge may be reached in a few hours from any point on the coast, and that this whole coast line is studded with fishing villages, itself shows that steam catchers which usually connote distant fishing grounds, stormy seas, and the need of powerful apparatus, are generally unnecessary and that sailers are primarily indicated. Yet this narrow accessible belt of equable sea is but slightly exploited ; the cubical contents of the regularly fished 5-mile belt, having an ordinary maximum depth of 10 fathoms and an average depth all over of 5 fathoms, when compared with the cubical contents of the 100-fathom belt, are probably not 1/40 on the East Coast and 1/70 on the West Coast.

12. Now it is true that the whole belt is probably not so prolific in fish life as the inshore 5 miles, into which the fish come in shoals whether for spawning or feeding or driven by the shoals of predaceous fish ; it is known that the inshore waters absolutely teem with immature fish which are daily caught by millions in the inshore seines. Yet there is evidence enough to show that the outer parts of the belt abound in fish life ; the boats that go out more than 5 or 6 miles, whether the Ratnagiri boats off Mangalore, the Bombay boats which I have met 40 miles outside of Bombay, the results of occasional excursions up to 10 or 12 miles by catamarans, the evidence of steamer captains and others, including myself, that on the West Coast vast shoals of sardine and mackerel are frequently seen 10 and more miles out at sea when the inshore fishermen are lamenting the total absence of fish, show that fish are probably abundant anywhere up to the 100-fathom limit. But the catamaran and canoe cannot go out to seek such fish or remain out to follow them, and for this reason therefore larger boats are absolutely necessary if fishing is to be developed, and if the inshore waters are to be less destructively exploited than at present.

13. Owing moreover, to the smallness of the boats and their poor sailing capacity a vast amount of time is spent in the incessant voyages to and from the grounds ; I have seen men on the West Coast labouring with the oars for several hours to get home, or hoisting their own cloths on oars as sails to their mastless boats, while the

sailing speed even of catamarans is poor ; almost half the time is spent in going to and fro when the distance exceeds 3 or 4 miles. Moreover, a boat of 40 to 50 tons does not require a crew of more than 10 or 12, whereas two large and two small catamarans or two medium canoes will require the larger of these numbers ; a crew of 3 or 4 men, aided by simple mechanical contrivances (capstans, etc.), will manage a boat and nets far more powerful and productive than several canoes or large catamarans on which manual labour is cramped by the character of the boats and no mechanical appliances are even possible.

14. But larger boats can work better nets—trawls included—both as being more powerful and as admitting the freer use of labour and the application of mechanical appliances ; the largest fleet of drift nets I have seen is that of the Masulipatam boats, but in this case length is only obtained at the sacrifice of depth. A fleet or set of herring or mackerel drift nets in England or Scotland will be between 1 and 2 miles long and 10 yards deep and is worked by a single sailer ; a Masulipatam boat takes nets one-third of a mile long when shot and 4 to 5 yards deep. Moreover, canoes and catamarans are too small to take more than one set of nets, and on the West Coast it frequently happens that on going out with one class of net the fishing is found to require a different sort, and the whole voyage to and fro must again be made to fetch them. The only drag net known in these waters is the Madras Coast "thuri," a trawl-shaped bag net towed by two catamarans just like a similar but larger net in the Mediterranean ; this however is not a ground net but mid-water and has little catching power ; only a large boat can use a real trawl. So also in the case of long lines, though size is here less essential so far as mere catching is concerned ; these long lines are occasionally found on the West Coast and have as many as 400 hooks, but these are small and light and used in shallow water compared with the heavy 7,000 hook lines seven miles long of the British boats (sail or steam) which will fish up to 360 fathoms for cod, halibut, etc.

Hence large sailing boats are imperative—

(*a*) to take crews safely and comfortably into the further waters of the fishing grounds and to allow them to stay there following and catching the shoals ;

(*b*) to allow of the use of better and more powerful nets and lines ;

(*c*) to save time, to lessen the number of hands and increase their freedom of action, and to permit of the use of mechanical appliances to save labour and increase efficiency.

15. But there is a fourth and absolutely important reason, viz., the proper preservation of the fish without taint from catch to shore ; it is probably the inability of a primitive industry to solve this difficulty that has largely prevented the development of the boats and therefore of the industry. The difficulty is great enough even in temperate or cold latitudes such as Great Britain and Norway, where, moreover, coal and ice are cheap ; in a tropical climate where a few hours bring taint, where coal and ice are excessively dear, where salt has hitherto been very expensive, and where scientific ignorance in those persons who catch and deal in fish is—with few exceptions—complete, the difficulty has been insurmountable ; if we cannot obtain cheap preservation, it is of little use hoping to develop a direct food harvest of fish, though we may turn it into manure and indirectly, therefore, into food. Even as regards Scotch pickled herrings complaints have recently been made in the European market, that fish have sometimes been of bad quality from having been put too late into salt, and that the boats should either return daily to port or be provided, like the Dutch and other foreign boats, with the necessary apparatus for complete curing on board. If this is liable to be the case even from brief delays in a temperate climate, what would be thought of our fish seldom put into cure until not only has freshness departed but taint has approached or arrived. On submitting the conditions to experts in Great Britain, America and Germany, whether officials or trade experts, there was but one opinion, viz., that the question of *preservation* is the crux of the whole problem in Madras. It is this, then, that will have to be primarily dealt with in the experimental station.

16. Fortunately, the problem is not insoluble ; by simple means accessible to all without expense, taint may be deferred ; by other means it may be prevented. But the larger boat is for this purpose almost a *sine qua non*. By a third method taint may be obviated, viz.,

by the acceleration of transit to shore. The matter divides into two main branches—

(*a*) the preservation of fish from taint from the moment of catching to the shore ;

(*b*) its further preservation from the shore (1) to contiguous markets as fresh fish, (2) to inland markets either as fresh or cured fish.

17. *Point* (*a*).—Taking first the third method—acceleration of transit to shore. This is a method of modern invention, viz., the collection of fish from boats at sea by a swift carrier boat which then makes its way direct to shore. This method has the great advantage that boats at sea, perhaps in the midst of making large catches, need not waste time and labour in individually running to port with a few boxes of fish ; the carrier can easily take the fish of a score of boats. Further, and this is here the point, much time is saved—

(1) because the catches can often be taken away by a carrier *as soon as caught* instead of waiting till the fishing boat finds it worth while to go home ;

(2) because the carrier is faster than the fishing boats.

This latter is specially the case when, as is now possible even in India, the carrier may be driven by steam or motor. The method, however, is only incipient in this Presidency ; there are traces, as at Muttupet, where large boats go out to collect the catches of catamarans, but this seems rather to be done after the catches have come to shore ; on the West Coast fish buyers send out to buy mackerel, etc., from the boats ; this seemed to be merely an attempt to be first in the market. The French sardine canner at Mahé is said to have bought or intended to buy a motor boat to get his sardines speedily from the boats—mostly inshore—, but at Bombay it appears to be the rule for swift sailing carriers to collect the catches of boats often 20 to 30 miles out at sea and to bring them straight to market. This method will greatly improve Madras practice ; boats have often got good catches several hours before they can start back, so that the early catches have frequently passed the rigor stage before reaching shore ; the carrier would save this. Moreover, the carrier can add preservative improvements :

(1) she may carry a little ice if ice is accessible as at Madras and Calicut, for there would be little wastage in the case of a mere carrier on a short voyage ;

(2) she can be kept perfectly clean and even sterilized by the use of the disinfectants invariably used on fish carriers and fishing boats in Great Britain, and without which, as Billingsgate and Grimsby owners assured me, they would run great risks in summer ;

(3) her crew can gut and clean the catches (if not already gutted) on board during the return voyage, if ice is not taken ;

(4) the carrier may be fitted up with live chests or wells in which to bring fish alive to the shore and thus obviate all question of taint.

The experimental station will deal with the carrier question by practical experiment.

18. Now carriers require organization either amongst the fishermen, which is unusual, or among the buyers, and considerable local markets or the demands of a factory are usually presupposed when carriers are used ; they will be needed at Madras and other large centres either of population or communication. But when carriers are not established and boats work independently there are other means of preserving fish from taint as far as the shore—

(1) *Absolute cleanliness.*—There is no fault to find with the catamaran here ; it is washed incessantly by the sea, and it is at once hauled up in pieces on the shore and exposed to thorough disinfection by insolation in a tropical sun. The dug-out is occasionally washed but never disinfected, and often fairly reeks with " an ancient and fishlike smell " ; this should be counteracted by thorough washing and the frequent use of a cheap disinfectant, e.g., Pearson's.

(2) *The gutting and cleaning of the fish on the boat.*—For this and all following methods the need for larger boats is obvious, since elbow room and storage room are necessary. At Billingsgate, Grimsby, Lowestoft, etc , practically the whole of the fish, except herrings, coming to market have been gutted and thoroughly cleaned in the fishing boats ; herrings are the exception as they are too numerous and bulky, and gutting is not practised at all for bloaters. All other fish are gutted for the simple reason that the

intestines, usually full of partly decomposed matter, are necessarily the first to break down and putrefy, thus starting the process in the tissues at an unnecessarily early hour; the prudent fisherman has learnt this by experience and minimizes his risks. I have seen hundreds of boats unloaded in this Presidency and have never yet seen gutted fish arrive; gutting is not practised, probably because there is really no elbow room on the catamaran or canoe; nay, I have never seen the so-called fresh fish arrive gutted at the markets. Yet if gutting is necessary in temperate and cold regions it is, *a fortiori*, essential in tropical climates where fish often arrives on shore in a tainted state. Gutting at sea would have the additional advantages that the guts would serve as attractive food and bait in the sea and that the nuisance of their decomposition on the sea-shore and backyards would be avoided. All large and valuable fish at least should thus be treated; some authorities recommend blooding them also. Apart from questions of curing, it is also well to wash the interior of fish intended to be sold fresh with salt water to which a little simple preservative has been added.

(3) *The proper treatment of fish when caught and cleaned.*—At present fish are thrown in a mass into the bottom of the canoe or into a coir net on the floor of the catamaran, and left slowly to struggle to death, the process often taking hours since the death agony is prolonged by accidental splashes of salt water. It is notorious that fish which struggle to death decompose much more rapidly than those caught and instantly killed, and it is recommended that the Western practice of knocking valuable fish on the head at once should, even on humanitarian grounds, be followed. Moreover, fish should be stored in an orderly manner and not thrown into a heap in the bottom of the boat where they are repeatedly trodden upon and exposed to the full glare of the sun as is the case in the canoes. In brief, boats should be cleaned and occasionally disinfected, and most of the fish should be killed, gutted, cleaned, washed with preservative (e.g., sea water with a little borax), protected from inconsiderate bruising, and kept out of the sun if it is desired to protect them from an unnecessarily early approach of taint between catch and shore. The practice and inculcation of

these precautions will be studied at the experimental station.

There is also, for cured fish, a plan of some promise, viz., a modification of the cod banks system of a mother-boat with her swarm of dories (small open boats) which do most of the actual fishing and bring the catches to her to be cleaned and salted down. A large boat provided with proper curing arrangements on board, might easily stay well out at sea for weeks together receiving continually the catches from the ordinary smaller boats and treating them on the spot. This, however, will only be necessary should there be a development of real deep sea fishing at some distance from land.

19. But one obvious improvement in preventing taint is in preventing death; in other words the use of the live well, live chest, or live car is to be strongly urged on practical men. It is astonishing that nowhere in India—so far as I can ascertain—is this simple and natural precaution found; in Great Britain, Holland, Scandinavia, Germany, etc., it is still common notwithstanding the present rapidity of communication and universal use of cheap ice. The welled smacks of Grimsby, etc., that is, smacks built with a compartment amidships open by auger holes to the sea, in which live cod, etc., were placed and brought alive to land, were very common till a few years ago, as also the live chests in the harbour in which the live cod were placed till needed for market; these have now partly died out but are still well known, and I have inspected at Grimsby large steam liners provided with these compartments which had just brought thousands of live cod to the wharf from the fishing grounds hundreds of miles distant and hundreds of fathoms deep; in America and Grimsby I saw live cars in use, i.e., chests shaped like canoes but covered in and bored with holes, into which the fish were placed and towed behind the fishing boat; in Norway the cod are not only brought in this same way to shore but are put into market tanks whence they are sold to purchasers; on the Danube steamers may be seen towing a chain of live cars; in Japan I have seen them made of bamboo and torpedo shaped so as to be towed readily through the water. Where live wells or cars are not used it is often the practice to have on the boats closed

compartments, chests, or barrels of sea water constantly renewed by a pump or aerated by a simple air pump. In this country the only trace of such is in the fine meshed rattan baskets in which Maldive islanders keep their bait in the lagoons; not even in Bombay is the practice found so far as my enquiries tell me; the very idea seemed inconceivable when propounded and queries addressed to Bombay authorities have received only a negative answer.

20. Many boats are powerful enough to tow light bamboo live cages behind them or at least to keep these fish alive in such cages till they actually turn homeward when, if necessary, the cages could be taken on the boat. The West Coast canoes are generally manned by six to eight men who readily row the boat home; the drag of a light torpedo shaped car behind them would not add seriously to the effort, while the advantages of live fish would be enormous; the Ratnagiri boats could certainly do so; even the larger catamarans, having considerable sailing power, could do the same. The matter of the live well, chest, or car is of such vast importance that their use, whether on board the proposed new sailers or in connection with existing boats, will be closely and continuously worked at in the experimental stations; also the cognate one of storing surplus fish alive in chests near shore since catches, *e.g.*, of pomfret, are often made in excess of a demand commensurate with their value, and chests would equalize demand and supply and consequently prices.

21. Ice or refrigeration has not been entered as a preservative for boats actually engaged in fishing; in existing boats there is of course no possibility of using it, and even on improved boats its storage would be wasteful and its prime cost prohibitive, except in the case of special boats deliberately worked for high priced markets only.

Artificial ice in England costs—including all charges such as depreciation, superintendence, etc.—about £0-7-6 per ton to make on the large scale; wastage is comparatively small owing to climate and the most approved modes of handling (e.g., rapid breaking by machinery, and its transfer by a long shoot and archimedean screw direct from the factory into the ice hold of the boats); to the fishermen it costs from 10 shillings

to 12 shillings per ton. In Madras the cost of production—including all charges—is between Rs. 14 and Rs. 20 per ton according to the large or small size of the machine, factory wastage is large owing to climate, and ice supplied in small quantities to boats at some distance from the factory and kept in the necessarily inferior storage of comparatively small boats, would largely be wasted. Hence even if supplied at 80 lb. per rupee or Rs. 28 per ton, the cost would represent at least $\frac{1}{4}$ anna per lb. of fish cooled, even on normal catches, and more on short catches. While the small or special trade which intends to sell only prime fish at $2\frac{1}{2}$ to 5 annas per lb. either in Madras or up-country, could afford this outlay which would simply fall on the consumer, it would be out of the question in the general trade in which the rise of 3 pies per lb. would be prohibitive, so that the catamaran men would out-sell and crush such an enterprise. Moreover ice is only available, and at dear rates, in Madras and Calicut, and it is unlikely that other centres will start large factories at any early date. Ice for fishing boats may, for the present, be put aside.

But for carriers there is less difficulty; the carrier's sole duty is to collect fish as rapidly as possible in voyages of short duration; it would be fitted solely for the purpose with a proper ice room and could almost always be sure of collecting enough to utilize her ice; there would be little wastage as her ice room would be always at a low temperature so that there would be little daily loss. The quality of fish (gutted on the fishing boats) would be superior and condition perfectly sound, so that it could be sold in Madras or sent up-country with the practical certainty of good prices; the up-country market is at present small because consumers will not risk buying at high prices fish which frequently turns out soft and uneatable. Even moderately priced fish may, if the carriers are of good size with good storage rooms, be placed in ice as the bulk of the cost will be paid by the high priced fish, and that charged to the second class will be small. Hence the supply of ice to carriers will be a matter of early experiment.

22. *Point* (*b*) *of paragraph* 16.—The question of preserving fish after reaching shore is of the greatest importance but presents less difficulty than the former question, in that facilities for storing, handling, and

general manipulation are far easier. The problem is two-fold, viz., (*a*) the preservation of fish in a fresh state, (*b*) its proper curing. The arrival of the fish on shore free from taint is postulated.

23. (*a*) *Fish to be sold fresh.*—Where the market is of moderate size and close at hand, there is no difficulty worth consideration; it is the fault of the consumers if they buy tainted fish. But there are the cases (1) of very large seaside markets such as Madras, (2) of inland markets; in the first case the local supply is insufficient and fish is brought from afar, as for instance from Pulicat to Madras, a distance at present requiring at least 5 hours of canal and road journey; in the second case the fish is necessarily transported to a varying distance; 10 or 12 miles from the coast is almost the ordinary road limit, at which distance the fish, as at present brought to shore, sold, roughly packed—without ice, of course—and carried by coolies (occasionally by jutka), is usually high if not putrid; if sent by rail to large stations such as the Nilgiris, Bangalore, Salem, Trichinopoly, it is packed in ice if sent from Madras or Calicut, or without ice from other fishing ports; for such goods high prices are paid often with unsatisfactory results; even in Bombay I hear that fish packed in ice and sent from northern ports during the monsoon is largely condemned by the Bombay market inspectors. As for fresh fish packed without ice and sent some hours journey by rail in an ordinary van, it has no claim whatever to be called "fresh" on arrival. To make iced fresh fish an article of regular trade requires above all things *organization*; the present individual, haphazard methods are useless; the organization must begin at the very beginning and organize (1) the catching, collection and transport of fish to shore in such a way that it shall *ensure* the fish being alive or absolutely sound on arrival; (2) it must organize so that the fish shall be brought direct by carrier to the market or to the place where ice or proper preservative methods are available, and not collected by slow land transport from distant fishing villages; for up-country trade such place must also be a railway station whence the packed goods can immediately be despatched; (3) it must organize agents at up-country stations in such wise that the collective orders shall always be fairly constant, so that the

railways may, as they then will, provide not only special refrigerating cars, but favourable rates; (4) it must organize so that the supply of ice, packing, etc., shall be as abundant and cheap as the climate will permit, for ice even at 4 pies per lb. (£3–2–6 per ton) for an Indian fish trade is absurd. At present no proper organization exists, though there are beginnings; conditions (1) and (2) are however not observed, (3) so partially that the railways can give no special facilities, and (4) only partially, viz., in the case of one or two firms which can command ice.

The experimental station cannot deal completely with this problem which is a trade question, save by hammering at the proper treatment of fish up to shore, by instituting—as is desirable for other purposes—a temporary carrier, by illustrating in a small refrigerating plant the possibilities of cold storage as when the supply of fish on hand exceeds the demand, and by co-operating with and stimulating business firms.*

24. But *iced* fresh fish must, for many years, be a luxury confined to the well-to-do; the fresh fish trade *for the multitude, i.e.*, preserved without ice, may however, be somewhat, perhaps largely, developed; if fish are alive or quite fresh at shore as the new methods may ensure, they may be despatched further inland than 10 or 12 miles; given also certain preservative precautions and they may be sent still further; an enlargement of the fresh fish belt from 10 miles to 20 or 30 would enormously increase the population reached. This introduces the question of preservatives which, apart from ice, has been only alluded to, but must now be fully considered.

25. Absolute soundness is a primary necessity whether the fish are to be sold fresh or cured or canned. This is not properly observed in this Presidency especially in cured fish, for the reason that not only are fish often tainted or on the verge of taint when brought to shore but they are then hawked about for sale as fresh fish, and only those which cannot be so sold are sent for

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* A method of freezing fish, as invented by Mr. J. R. Henderson of London who has permitted the free use of the invention in India, is now (1915) being tried in the experimental station at Beypore: fish treated by this method can be safely transported without ice and in ordinary packing for at least a 24-hour journey.

"cure"; except in the cases when there are large surpluses of fish, as when sardines and mackerel are caught in masses, or when well-to-do curers—as at Tellicherry—control fishermen for the sole purpose of curing, it is the general rule that fish brought to the curing yards, public or domestic, are already tainted. Even where fish are caught purposely for curing, as at Tellicherry, the delays and poor treatment often cause incipient taint; fish caught in the morning and not brought to the yard till 4 P.M. are necessarily in that way. But fish once tainted cannot be restored to soundness; decay may be arrested or, what is hygienically dangerous, disguised or concealed, but its pristine soundness and *wholesomeness* are gone, since the alkaloidal poisons (ptomaines) and toxins resulting from the action of putrefactive bacteria in animal tissues, are not necessarily destroyed by icing or curing or canning even when the bacteria themselves are destroyed; still less when they are merely arrested in progress. But bacterial action is not only more speedy and the resulting poisons formed more readily in the less compact tissues of fish than in those of other animals, but—*experto crede*—the poisons are peculiarly deadly, simulating the symptoms of cholera and other bowel diseases; other diseases of the digestive and intestinal apparatus are caused by the use of putrid fish, and one great authority claims that leprosy is the direct result. When we note that much of the "fresh" fish sold outside city markets and practically the whole of the salt and dried ("cured") fish is tainted either thoroughly or partially, often to a degree insupportable to European stomachs, it becomes absolutely necessary to deal with the subject at the source, and not to disguise or merely arrest but to *prevent* even the access of taint. At present everything is against success; the climate which gives only hours of soundness when a cold climate gives days; dearness of all preservatives such as ice and salt; dearness of steam or motor fuel; absolute ignorance by fishermen and curers; carelessness, possibly preference, by consumers. Hence very careful and prolonged experiments will be needed to ascertain methods which will be complete, cheap, wholesome, and acceptable to the public.

26. In Europe the necessity for preservatives is admitted notwithstanding its climate, abundant ice, and

rapid communications; witness the enormous number of patent specialities usually of boric compounds and salt, such as Arcticanus, Keeps' Preservative, Glacialin, Preservitas, Sal preservare, Preservalin, Berlinite, Magdeburg salt, boro-glyceride, etc., etc.; the wide advertisements and large sales of these show how greatly they are used, and it has been stated that "practically every person in the United Kingdom who has passed the suckling stage consumes daily more or less food containing chemical preservatives" (Thresh and Porter). Here in India the case for the moderate and skilled use of preservatives is much stronger for the obvious reasons above stated; we have to decide between, on the one hand, the continuance of a very scanty supply of food not only unnecessarily scanty but often so tainted as to be very deleterious to health, and, on the other hand, the moderate use of simple and innocuous preservatives; with preservatives we can render wholesome the existing supply and immensely develop that supply; without preservatives we must to a very great extent continue as we are.

That is the choice laid before us in this tropical climate and in the absence of refrigeration, viz., either to refuse a great increase to our food supply and favour the continuance of a small, septic, dangerous, and often toxic supply, or to accept the moderate use of preservatives and antiseptics which are known to be absolutely innocuous in the small and occasional quantities which consumers of fish might possibly take; *possibly*, but not necessarily, since the preservatives tend to disappear, and sometimes wholly disappear, in the processes of curing, washing, cooking, etc. The Parliamentary Departmental Committee on Food Preservatives in 1901 deliberately recorded the following verdict:—

"We have come to the conclusion that as regards the trade in fresh and cured meat, *fish*, butter, margarine, and other food substances in the consumption of which but small quantities of the antiseptic are taken into the system, there exists no sufficient reason for interfering to prevent the use of boron preservatives."

It will be observed that butter and margarine are included, in which substances the preservatives are intermixed and consequently taken in their entirety into the system, whereas they are used chiefly as a mere

antiseptic wash or external application in the case of fish, and are therefore usually removed, wholly or partly, in cooking, etc., prior to consumption. Briefly the choice lies between dangerous toxins and innocuous antiseptics ; between abundance of wholesome protected food, and a poor supply of deteriorating or deteriorated products.

Hence one of the main objects of experiment is the due use of recognized and harmless preservatives and preservative methods merely as supplementary to the older ones of salt and sun, starting with the improvement of the old and proceeding to the introduction of new methods.

27. As regards fresh fish not much can be done without ice after the fish have come to shore, but with the precautions already mentioned of gutting, cleaning, washing with salt and borax, and very light salting, much can be done on board, to which may be added a *sterilization* process of recent development mentioned in the proposals below and which will, in my own experience, keep fish fresh and wholesome, without the slightest taint or fly-blow, for weeks in an English summer.

28. *Cured fish.*—But as regards the up-country and export trade it is cured fish on which we must rely ; this must for years be the stand by for popular consumption and to this the main portion of our experiments will be devoted. Hence (1) the present conditions and methods and (2) improved methods must be considered.

The present methods in brief are—

(1) the drying of small fish on the sand without gutting or salt ; the very crudest of processes, in which the proportion of sand wilfully or accidentally mixed with the product is outrageous, averaging at present (Dr. Lehmann) 33 per cent. (and rising to my own knowledge to 44 per cent.) of the total as against 6 or 8 per cent. a few years ago ; the huge excess now found compared with previous years shows that the adulteration is deliberate or at least avoidable, and the Indian Fisheries Company is greatly hampered by the adulteration which tends to choke the nascent industry in fish fertilizer and oil ;

(2) the salting and sun-drying of fish of all sizes from sardines to shark ;

(3) the salting without sun-drying of fish, especially large ones, in which the process is varied by stacking the fish in rectangular heaps above ground so as to squeeze out much of the moisture, or by piling it in pits or troughs below ground with a similar object. No other processes are general though there are significant variants, chiefly domestic or for a special trade; valuable as showing that other methods are available and approved of. Such are the pickled mackerel of Cochin in which mackerel are packed in barrels with salt and Malabar tamarind (guraka puli); the result is a hard black product which is consumed only in Ceylon, for which it is specially prepared. Another is the drying of bonito flesh, a practice of the Laccadives only, the product of which is in hard brown strips, capable of keeping for a long while; this largely corresponds with a Japanese method. A third excellent method is domestic only, viz., the well-known "tamarind fish" now little known to the public, but capable of much development. A fourth has still greater possibilities and has been found in two or three places chiefly on the East Coast but only for special markets; this is the use of *turmeric* with salt, the former condiment having apparently great preservative power; turmeric is cheap and universally liked by Indian consumers, and if, on experiment, its preservative powers realize expectations, a good and absolutely wholesome article, acceptable to popular tastes, will have been discovered. Here the list of Madras methods ends, though in Bombay market I discovered excellent goods, in which pepper was one of the preservative condiments; the recipe will be ascertained hereafter as the product was excellent in appearance and smell, and firm to the touch.

29. As indicated in my West Coast report, the general curing methods leave almost everything to be desired, and East Coast practices are in some ways worse—

(1) the fish are often tainted on reaching the yard;

(2) the amount of salt used is insufficient;

(3) the fish are left too short a time in salt;

(4) the goods are dried on the ground whether with or without mats, so that the under side for the time being obtains neither sun nor air; as is well known,

the side nearest the ground invariably taints rapidly, notwithstanding occasional turning ;

(5) the fish lie in the full blaze of a tropical sun so that the outside is toasted while the inside, especially when the flesh is thick, remains moist just *because* the outside is toasted, a condition in the highest degree favourable for bacterial growth and ravages ; it is known that the dryage of large fish is insufficient since the fish-curing yards for large and small fish together show a dryage of only 40 per cent. (50,000 tons wet into 30,000 dry, in round figures), so that large fish do not lose above 30 per cent., while they contain, when green, 75 to 80 per cent. of water ; the result is a steady continuance of putrefaction even after the so-called "cure", since bacterial action is only stopped by a considerable degree of dryness. The toasted product is neither firm nor sweet, and much of it would be thrown into the manure tanks in any Western market.

30. The remedies which will be experimented on are—

(1) the use of more salt such as is given even in Western climates ;

(2) a longer stay in the salt ;

(3) the use of pressure in stacks (and other methods) for the removal of moisture preparatory to, or without, sun-drying ;

(4) the use, as is invariable in the West, of rough frames (flakes) two or three feet high, carrying trays of coarse wire netting or bamboo trellis work on which the fish lie so as to dry equally on both sides ; or scaffolds on which the fish are hung ;

(5) protection from the direct rays of the sun, as in the West where screens are provided so as to avoid toasting ;

(6) a greater degree of dryage.

The use of more salt and a longer stay in salt will permit of *slow* air-drying, a matter of much importance in order that the product may be dried throughout. Pressure is, in the West (as in the Ratnagiri methods at Malpē), an invariable adjunct to drying in the case of large fish, but there are other simple physical methods for quickly getting rid of the superfluous extra-cellular water lying amongst the tissues before applying the slow process of pressure in stacks which is efficacious rather

in expressing the intra-cellular moisture extracted from the tissue cells by the salt. A small amount of other preservatives may be applied with the salt to increase its antiseptic and plasmolysing effect. Artificial drying by very simple and cheap methods such as I have seen in operation will also be tried.

31. It will be noticed that in this Presidency (practically in India generally) there is in use no such method of curing as the smoking, wet pickling, mealing, and canning of Western countries. The preference universally given to *drying*, with or without salting, is easily explicable—

(1) Complete drying is one of the best as well as simplest and handiest modes of preserving animal products ; bacteria cannot act in the absence of moisture and the powerful sun is always at hand to dry without cost ; salt is used both as an antiseptic and to hasten the dryage of the tissues ;

(2) in drying a smaller amount of salt is needed than in wet methods, a matter of chief importance where salt is very expensive ;

(3) the nutritive value is retained by simple drying whereas much is lost in heavily salted goods through the extraction by the salt of nutritive fluids from the cells ; it is true, however, that extreme drying reduces digestibility and, consequently, its nutrient quality ;

(4) by the great reduction in weight, transport difficulties and charges are reduced to a minimum, a most important point where communications are or have been defective and journeys lengthy ;

(5) no packing is required beyond simple matting, and this again lessens cost as well as weight and bulk for transport ;

(6) no expensive machinery, plant or stock, is required as in the making of barrels, etc. ;

(7) the result is that sun-dried fish is probably the cheapest of all preserved goods.

These advantages are still of great importance though not so much as 20 years ago when transport facilities were far less and salt extravagantly dear. Hence the experimental station will lend its chief efforts in curing to the supply of the goods to which the public has become accustomed, but improved, cured through, and absolutely wholesome in character, such as the dried salt cod of America, Norway and England.

32. *Smoking* has the advantages—

(1) that it is antiseptic and even disinfectant;

(2) that it begins to operate *immediately*, so that the goods are practically free from the access of taint as soon as they are placed in the smoke;

(3) no preservative other than salt and the constituents of the smoke are needed;

(4) the constituents of the smoke are not only innocuous but even hygienic;

(5) the flavour of properly smoked fish is acceptable and agreeable to judge by the practical universality of the process elsewhere than in India, where it is almost unknown.

For these reasons I intend to make full experiments in smoking; experiments which will need the trial of various methods, duration of smoking, classes of fish, woods, markets, etc.

33. *Wet pickling* is the placing of fresh fish, especially herrings and mackerel, alternated with layers of salt, in barrels; the natural moisture of the fish forms with the salt a very strong brine or pickling liquor in which the fish stand; after some day the barrel is filled full, headed up, and sold; the fish if strongly salted in tight barrels will keep for months.

The main advantage of pickled fish is that the fish as soon as gutted is neatly packed with abundance of salt in a closed barrel; hence the air is almost excluded from the outset, and since it is never removed from the salt or even from its place in the barrel, it is not only retained continuously under the influence of the preservative but is not exposed to the taints of the open air as is the case with sun-dried fish. This hygienic advantage is an immense one; properly pickled fish has absolutely no trace of taint of smell, but is firm and good; hence the immense demand for it in Russia, Germany, and Italy. The method is practically unknown in this Presidency (except as regards the pickled mackerel in Cochin for Colombo) and probably in India, chiefly, no doubt because of certain disadvantages, but in the attempt to provide wholesome food this method cannot be neglected and will therefore be a matter of experiment.

The disadvantages are—

(1) that whereas in dried salt fish the quantity of salt used is small, say one-fifth of the weight of the fish,

and much of that is lost by failure to dissolve and by efflorescence in drying, that used in pickling fish is far larger, viz., one-third or two-fifths of the weight of fish, and practically the whole of this remains with the fish in the barrel and passes to the purchaser and may partly be recovered from the brine; hence the Salt Revenue authorities may object to granting cheap salt in the fish-curing yards, and it may be necessary to use excised salt which is perhaps possible at present rates;

(2) that some of the nutriment contained in the tissue cells is extracted by the salt and passes into the brine where it is lost to the consumer;

(3) that a given weight of fresh fish placed in pickle weighs with the salt and barrel two or three times as much as the same weight when properly dried, so that transport charges are heavy;

(4) that the barrel is difficult to make and an addition to the cost.

Nevertheless it appears probable that there will be a market among the better-off classes for these goods, and an export trade with Ceylon and China is a possibility to be reckoned with.

It will be necessary in this connection to experiment not only on the methods and material most suitable, viz., the best classes of fish, the quantity of salt, etc., but on the woods available for barrel staves and on the industry of coopering, for which a master-cooper will be necessary.

34. *Mealing* or shredding is a process not much known but of which much may be hoped. In the United States, especially at Gloucester, Mass., I have seen shredded salt cod which is a very admirable production, being perfectly sound, moderately salt, thoroughly dry, and palatable; this is only akin to mealed fish, however, which is a dry coarse powder with a pleasant if somewhat strong smell, and is produced largely in Norway and Germany; at Geestemund the fish meal which I saw was thoroughly edible, though sold for trout food. The advantages are—

(1) that if the fish when taken from the salt is at once deprived, mechanically or otherwise, of the bulk of its more tangible or extra-cellular moisture, it can be rapidly shredded or ground, and in that state will dry not only thoroughly but with far greater rapidity than

when solid; hence it can be put beyond the attacks of bacteria—which require a certain degree of moisture—before the setting in of taint;

(2) that since all large bones and inedible portions are removed while small ones are ground up with the meal, the product is purely food of a very nutritious and building-up character, and though costly, weight for weight, as compared with country salt fish, it will be less costly in reality since the article purchased will be wholly edible and wholesome and not consist largely of inedible matter (bones, skin, etc.) and of useless or ptomaine-laden moisture; after all, the Geestemund product, consisting of haddock and other edible fish not marketable simply because undersized, is sold at one anna per pound;

(3) it can be compressed into small packages so that its transport will be cheap, especially considering that it will be all food and not bones and skin and moisture;

(4) it will keep well.

Hence fish mealing will form the subject of early experiment, and shredded shark or dog fish may become as popular in Madras as pounded shark in Japan.

35. *Canning* is naturally one of the first items for experiment since—

(1) the process, properly conducted and checked, provides a thoroughly sterilised food completely protected from the possibility of further taint while in the can all bacteria present in the fish when placed in the can are destroyed by a heat above 212° F., and their further access prevented by hermetical closure;

(2) the product can be varied in scores of ways to suit public requirements; the containing fluids and sauces, the oils and condiments used, can be modified at pleasure;

(3) the product can be exported, and Indian cheap labour and tastefulness would have a fair chance of success; the Japanese are believed to be succeeding even in American markets.

The disadvantages are—

(1) the cost of the plant;

(2) the necessity for delicate, rapid, and absolutely honest handling if safe goods are to be secured;

(3) the final cost of the product;

(4) only certain fish such as sardines, mackerel, seer, etc., seem suitable for canning and these are not always or everywhere available.

To this it is replied that there is a large market for canned goods of moderate price even in India and Ceylon ; especially in large towns, and that this market may be extended to other Eastern countries and Australia ; that a French canner in Mahé is making a success of the business and hopes to develop it, probably by extending the area and accelerating the speed of his buying operations ; that his goods are cheap and evidently acceptable to the public, though little advertised ; that there must be room for several canning houses ; and that it is the very object of experimental stations to ascertain what fish may readily and acceptably be canned, and the markets available. Canning is therefore entered as an experiment to be tried forthwith ; it was the very first object of experiment in Japan.

36. Miscellaneous methods such as pickling in vinegar, treatment with turmeric, etc. are practically unknown though very valuable ; there are traces of these methods in a few places, as when some toddy or tamarind is used or turmeric and salt applied to slices of fish ; probably one of the best and safest methods of preservation will be found in the use of the above condiments, which are cheap, common, indigenous, and acceptable to the people. They will be matters of pure experiment, that is, there is little or no Western experience to guide attempts, and the acceptability of the products is uncertain though probable.

37. Argument is hardly necessary to show that if the above experiments are successfully carried out, viz., experiments in the best methods of bringing fish fresh to shore and of putting it cheaply on the market in various forms and free from taint, there will be a vast development of both the high price and low price markets, with a corresponding development and variety of industry and trade ; it is the *impossibility* hitherto of putting fish fresh on any but a coast market or of putting properly cured fish on *any* market, that has not merely hindered but absolutely debarred the rise of a fish industry and trade, of its correlated industries, and of an enlarged food supply for the public ; success in keeping fish fresh or in preserving it from taint will mean success in the

market, if it is found simultaneously possible to keep down the cost. Preservation is the crux of the whole problem, and the experimental station will attack this problem in every possible way and with all the aid that modern applied science can give.

38. But cheapness and acceptability are also essentials and must be studied no less carefully than soundness; any expert can produce first class salted fish dried or wet, or tins of good sardines, or excellent smoked seer, bonito, etc., but if the product is beyond the purse or not to the taste of the public there will be failure. The first duty, then, of the experimental station will be to find out successful methods, and then by a process of elimination and simplification to minimize the plant and all the items of cost till the lowest possible cost is attained. The goods can then be put on the market and their public acceptability ascertained ; it may be that putridity or, say, high flavour, is preferred by many, just as the Burmese love ngapi, but, *per contra*, it is certain that many are deterred from using the present product just because of its character ; it may also take a long time for the public to acquire the taste for smoked or pickled goods, or for canned goods to command confidence. Hence the work of the experimental station does not stop with creating the article, but time and money must be spent in creating or ascertaining a demand. It is of little use starting a station if this additional duty is not accepted.

39. But it is not proposed that the station shall work alone in these matters, especially in those relating to the distributing trade. It has been my endeavour always to awaken the interest and enlist the support of those already connected with the trade, and while, with few exceptions, such persons desire to await the result of experiments by Government whether in catching or curing, all avow a willingness to adopt and push results if successful, an attitude quite intelligible from their point of view ; as one Indian firm said " It is not a question of sentiment with us or of assisting industrial progress ; it is just a matter of rupees." Precisely the same was said to me by a London firm, with this radical difference, that the British firm at once started out to experiment, to spend money, thought, energy, and men on ascertaining facts and possibilities in view to getting the cream of the

business. Hence development in general waits on successful demonstration in the Experimental Station, and this may be accepted as customary, and is in fact the *raison d'être* of the Station. But there are exceptions; there are Indian firms and influential persons who will work with the Government in enquiring, in experimenting, and in pushing likely business, in working and utilizing the advantages of larger boats, in experimenting on live-wells and "cars" (live chests, canoe shaped, towed behind boats), in developing the use of carrier boats, in substituting power for manual labour where speed is essential, and in carrying out methods of preservation.

To mention concrete cases; it has been tentatively arranged that if Government find one or two improved sailing boats for catching, a firm will provide its own crew of expert fishermen as a business venture and that the live-well or live "car" system shall be tried in various ways. Further, it is admitted that for the fresh fish trade, whether on the Madras market or for iced fish sent up-country (a business now carried on casually and imperfectly), a carrier bringing all the fish from 10 or 15 miles on either side of Madras direct to the Madras harbour with the markets, ice factories and railways on the spot, will give infinitely better results than the present system of collecting fish by jutka or runner from the various kuppams (fishing hamlets) from Pulicat to Covelong to which the catamarans bring their catches: hence if a carrier be provided it will probably be run by a business firm who would doubtless buy it if successful. Again, small power boats on the canal will bring in fish from Pulicat, etc., faster and in better condition than at present, and enquiries have been made from me as to the feasibility of the practice and the initial and running cost. A very influential Indian gentleman directly connected with the industry has, on my suggestion, been experimenting in delaying taint by gutting and cleaning the fish at sea and packing them with certain precautions as to ventilation with the result that even in this weather he finds the access of taint to be delayed by many hours this result is of the highest practical value and is exactly in accordance with expectations. He is also desirous of falling in with my proposal to work larger boats (like the Bombay boats)

on this coast with the objects which I have enumerated above. Details for co-operative work will of course be separately reported to Government for consideration since expenditure will be necessary ; the subject is simply mentioned here to show that the policy of co-operation is possible and advisable, and will, if Government approve, be a leading role of the experimental station, especially in matters where public taste is a primary consideration.

40. This was largely the case in Japan ; in one of the earliest stations the canning industry was developed, neighbouring firms or persons were shown the products, and the expert was, it would seem, lent to a private firm which has now engaged him as manager for a large canning business equal to 2,000,000 cans per annum. Boats of a new class are built at or for the stations, and manned by or lent to groups of fishermen ; I found at one station that all the station boats were away with station instructors but local (independent) crews at Korea, etc., while the fishery schools take the lads and train them in boats and in a school factory in all branches of progress ; in one place the committee of a Fishery Chamber desired permission to go to sea on board the improved fishing boat of the experimental station in order to acquire a practical knowledge of its working (paragraph 120 of my note) ; *si sic in Indis* ! A somewhat similar method is found under the Congested Districts Board operations in Donegal where the Board builds or obtains large fishing boats for given groups of fishermen and works them on the share system, the fishermen, with one or two Board instructors, operating the boat and selling their catches ; in this case, however, the shares coming to the Board are credited to the fishing syndicate who thus gradually pay for and obtain the boat ; here also apprentices are trained both to the catching, curing, coopering, and boat building business ; in one place they have advanced capital to a boat building firm of good standing in order to develop its business in particular direction. It will be the effort of the experimental station to enlist public interest and co-operative effort in every form whether by public fishing associations, by business co-operation and assistance, by inviting inspection and by suggestion, by itinerant schools or demonstrational lectures, by leaflets

and pamphlets, and by the school and apprentice system.

41. The methods above outlined are intended to assist progress without undue disturbance to existing classes and systems, to introduce progress gradually, to evolve rather than to revolutionize, to work through and develop existing agencies rather than introduce outside enterprise.

42. *Culture.*—No attempts at culture will at first be made except in the direction of oysters and other shell fish. Marine pisciculture can only be undertaken by a highly developed department with a large organization and with full scientific knowledge; its results are of doubtful utility and its methods expensive; the system belongs to a later—the conservational—stage of development; hence it is passed over for the present with the exception mentioned. Oyster culture, however, is extremely easy and profitable and the results ascertainable; it is carried on in shallow water by the simplest of natural methods and is concerned only with immobile subjects which can be easily protected and handled, differing absolutely from the free swimming swarms of cod, etc., which are the subjects of the usual marine hatcheries and which are turned out in their most helpless age simply to form, in most cases, ready food for larger fish. The oyster remains where he is, his enemies can, to a great extent, be kept away, and when the harvest is ripe it can be reaped in full; it is eminently an industry suitable for the ordinary backwater fishermen when instructed. It is true that Indians do not generally eat oysters so that there would be but a small home market, but there is an absolutely unlimited demand for dried oysters and shell fish in China to which Japan sends large quantities, and there is an assurance of easy and vast production by culture in our backwaters and in parts of the coast such as the mangrove areas of Guntūr and Kistna; the oysters of Pulicat and Covelong are well known, and in the backwaters of the West Coast from Quilon to Hosdrug they abound, together with vast numbers of other shell fish; As. 4 per 100 is a fancy price for excellent Quilon oysters; the best in the country are said to come from the coasts near Chinna Ganjām, Nizampatam, etc., in the Guntūr district. From the casual inspection hitherto

possible of backwaters near Madras it is clear that oyster spat abounds ; oysters can be dredged up anywhere, and bricks, etc., from the bottom or edges are covered with young oysters often several generations deep. Pulicat, Ennore and Covelong lie close to Madras, and with Ennore as the site of the experimental station cultural operations can easily be supervised ; we have shallow water easily demarcated and protected, clutched, sown, conserved ; the first operations may be at Ennore, for though the oysters might not be desirable for food owing to contamination from the Madras section of the canal, the character and method of operations can be supervised and studied for future guidance. I propose then presently to start an oyster laying ground close to the proposed station at Ennore.

43. *Inspection boat.*—The provision of a boat for inspection, experiment, and research is necessary, if we are to learn anything about deep-sea conditions and the habits of fish, especially migratory, and be able, therefore, to indicate probable developments in catching. For instance ; on the West Coast the inshore fishermen are troubled and the development of the canning, the fish fertilizer and fish oil industries hampered, by the eccentricities of fish movements inshore ; sardines and mackerel appear, disappear, or fail to appear in the most bewildering manner ; in 1906 the mackerel catches reported by the fish-curing yards were only trifling as against a huge average for the previous 8 years ; this year again there is said to be a failure ; the same happens with sardines ; in a year or two there will probably be overwhelming catches. Yet in *every* year it is believed—as is probable—that the fish are there but not inshore ; I have myself seen a large sardine shoal 7 or 8 miles out but not a fishing boat in sight and not a sardine caught in that locality at that period ; captains of steamers report vast shoals "as far as the eye can see" 10 miles out, when the inshore fishermen are starving for want of catches. Hence an inspection boat is necessary to live on the sea at shoaling time, and to ascertain the existence, movements, etc., of shoals, so as to direct and stimulate deep-sea work. Again, these fish are caught in shoals in the extreme south of the East Coast, and in the coasts north of Masulipatam ; they never visit the central coast line. Presumably the

shoals are there but do not come inshore, and the use of a good inspection boat is necessary to ascertain facts and suggest effort. So, again, little is known of the possibilities of deep-sea fishing in East Coast waters during the south-west monsoon period, the best fishing season with catamarans being the short season from January to May inclusive; a power boat could investigate this question. Again, a boat is wanted for experimental trawling and dredging; the question whether trawling can possibly pay, e.g., whether there are bottom fish in any paying quantity, is absolutely unanswerable at present, and trials round the coast are essential; it is far *easier*, especially for experimental purposes, to do this with a power boat than with a sailer which must be of some size to trawl, and is largely dependent on wind and tide. I am informed that the Ceylon Pearl Fishery Company has recently conducted experimental trawling operations from Ceylon to Madras and near Cape Camorin, and that valuable information has been obtained; information as to results is at present inaccessible, as a private company is naturally secretive where competition is possible; hence Government operations, conducted solely for public information, are all the more necessary; I hope, however, shortly to be favoured by the company with a report as I have applied for the same. Again, it is necessary to ascertain the productive capacity of the sea outside the 100-fathom limits and the possibility of remunerative drift net fishing; a vast number of our fishes are surface or mid-water swimmers, especially shoalers, and for catching these with drift or purse nets the depth of the sea is, of course, immaterial, *if* the fish are there. Similarly we want to know something of the fish food (plankton) capacity of our waters and this can only be tested at sea. Dredging again is necessary, for we know nothing of the shell bearing capacity of our sea beds, and there are possibilities in shell, especially as I note that pearl shell is being exhausted in the Thursday Island regions and culture is spoken of as a necessity. Finally, the inspection boat is required for experimental use as a carrier; I do not propose to have a separate boat for such use, for a carrier is needed chiefly in the fresh fish or canning business, and these demand trade organizations which Government can

hardly undertake; our duty consists in demonstrating the utility of, perhaps the necessity for, the practice, and this can be done by experimental work with such boats as may be available.

I shall therefore eventually have to propose a power boat as a necessary part of our equipment, the boat being attached to the station but sent on roving commissions.

44. It will be seen that all proposals are directed to increasing the catches, to improving the quantity as well as the quality of the sea harvest, and that no word has been said regarding restrictions. My reason is this; that, probably, much less than one-twentieth part even of our limited grounds, is fully worked, and that efforts are consequently to be directed not indeed to increasing inshore catches, but to exploiting the real deep-sea grounds; those, for instance, beyond 10 or 15 fathoms; it is not yet the time for restriction, nor is enough known either of the exact nature of the catches inshore (i.e., within the 3-mile limit where restrictive rules would, if anywhere, chiefly be possible) or of the habits of the fish, to lay down even the simplest restrictive rule; that must be the work of a department, and one branch of the Experimental station's work will be observational, viz., to ascertain by a zoological scientist the character and seasons of inshore seine catches—which are known to be fearfully destructive of very immature fish life—and, generally, the habits of the fish. Hence I propose to attach a zoological assistant to stations (and elsewhere) in order that we may obtain facts for subsequent action if necessary.

45. But in one matter restriction is desirable, viz., that the new classes of sailers or power boats other than carriers shall fish *outside* the 3-mile limit. The principle which I have urged throughout is that of non-interference with existing catching methods; merely the introduction of superior and more powerful boats and methods to supplement, not to oust, the catamaran and canoe, by going into areas and depths where the latter are useless or impossible. The inshore waters are very sufficiently fished by shore seines, by nets and hooks and lines of many sorts; I desire merely the exploitation of deep-sea areas; the *raison d'être* of new boats and methods is deep-sea fishing. I would therefore prescribe a rule which my own boats will observe, that the new

boats shall fish solely outside of the 3-mile limit which is pretty well known. The rule will, for want of such boats, probably be inoperative for years to come and is merely laid down, at present, as a principle of policy.

Position of the First Station.

46. Having laid down the general lines of policy it remains to consider the position of the first station. This was originally intended to be Tellicherry, but I would now propose the Madras neighbourhood, viz., Ennore. My reasons have already been stated to Government, viz.—

"As elsewhere noted, the Indian Fisheries Company is starting large works,* partly of an experimental nature, at Cochin on the West Coast, and its operations will extend to other places than Cochin; these operations are intended to and, it is hoped, will cover experiments in all the items included under catching and curing. The conditions of the West Coast from Cochin to Mangalore are all similar both in the nature and depth of the sea, the breadth of the comparatively shallow (trawlable) area, the classes and seasons of fish produced, the classes of persons engaged, the implements used, and the communications available. Hence, experiments in Cochin will be as instructive to the whole West Coast as experiments at Tellicherry, and since the experiments have actually begun and should, by reason of abundance of funds and experts, be more rapidly and thoroughly conducted than any which Government could at once undertake, I consider that the proposed Government experimental station at Tellicherry should be transferred to the East Coast.

"The locality which I would now propose is Madras, or the neighbourhood not further north than Ennore or south than the Adayar. Apart from the reasons given above for transfer from Tellicherry, Madras is indicated as the best site for a station; it will probably be the head-quarters of the Fisheries administration; scientific talent and assistance—engineering, mechanical, chemical, etc., can always be drawn upon; the results of successful experiments will be noticed by competent

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* These were subsequently confined to a factory producing oil and "fish guano" from the oil-sardine (*Clupea longiceps*) of the coast.

observers and readily disseminated by the press or otherwise; the city is a centre of industrial and business enterprise and capital which will be able to adopt and push successful fishery and curing methods; there is a harbour in which any experimental vessels, such as steam trawlers, can shelter; hardy and expert fishermen are numerous, and the local agencies for placing fish on the market are experienced and eager to adopt ascertained improvements, especially in methods of bringing fish fresh and expediting its transit; the local market for fresh fish is unlimited, while, as the head-quarters of two main railways, experiments in the consignment of fresh fish to Bangalore and other distant markets can readily be undertaken; as a city where custom is less binding than in the districts, the market for new products such as pickled or smoked fish, could be tested and the taste for such goods diffused. I, therefore, suggest Madras; it is possible, however, that a sub-station for canning will have to be started in a locality where sardine are more abundant."

I think it quite clear from the sketch given above that, in view to co-operative effort, publicity, etc., Madras is the place indicated for first effort. At Ennore the Public Works bungalow with $5\frac{1}{2}$ acres of compound is admirably situated; it lies within a few hundred yards of the bar; the sea is within 100 yards on one side and the backwater within 10 yards on the other, while a large and powerful kuppam (fishing hamlet) is within 200 yards; Ennore itself is within half an hour of Madras by rail and 10 or 12 miles by road, and is frequented by fish merchants from Madras and fishermen from Pulicat, etc.; the canal also runs from Pulicat and the north to Madras *viâ* the backwater, affording opportunity for small oil launches; possibly also for live "cars," save that near Madras it is too filthy for safety, so that Ennore is the effective terminus. Ennore fulfils the requirements mentioned earlier in this paragraph, and as the Public Works bungalow is to be abandoned as such, I have proposed it to Government and it has been transferred to the fisheries department as the site for the experimental station.*

* Ennore was soon abandoned as unsuitable; the proximity of the great Madras market for fish prevented the station from buying fish which moreover, was only captured in moderate quantity. The open beach with its heavy surf also prohibited the use of boats other than catamarans.

THE CLASSES OF EXPERIMENT AND PLANT PROPOSED.

47. The plant for which I ask sanction for the experimental station is as follows:—

(1) Two sailing boats, about 15 tons each, complete with gear and stores, live chests, and live cars;

(2) Sets of various nets and lines;

(3) A 16-foot 2 horse-power petrol or paraffin dinghy for use on the canal and backwaters, especially Pulicat lake;

(4) Drying plant (inexpensive) including a manual power centrifugal, drying room variously heated (exhaust stoves, etc.), fan, etc.;

(5) Salting and drying plant including salting tubs and cisterns, scaffolds and platforms;

(6) Preserving and sterilizing plant including preservatives in common use (salt at fish-curing yard rates), a "Universal Sterilizer," electrolyzing plant, smoke shed, pickling barrels, etc.;

(7) A $3\frac{1}{2}$ horse-power oil-engine for the electrolyzer and other purposes, and wind mill for pumping sea-water;

(8) An inspection boat which may be used as a carrier, fitted with (kerosine) engines, power winch, etc., for trawling, net and warp rooms, salt hold, ice room, nets and dredges;

(9) Set of pearl button tools;

(10) Shedding necessary for the above plant;

(11) Small laboratory for zoological and chemical work accommodated in the existing building;

(12) Small reference library and museum, similarly accommodated; the library already contains about 400 volumes mostly of my own, which will be donated to the Fishery Bureau;

[(13) A small refrigerating plant, probably Linde's ammonia system;

(14) A canning plant.

Nos. 13 and 14 will be separately applied for hereafter.*]

48. *Boats.*—Two boats of about 15 tons each (tonnage $= \frac{\text{length} \times \text{breadth} \times \text{depth}}{130}$) will be needed; one for

* Both since obtained; the canning plant has successfully operated since January 1912, and a new and much improved "sanitary can" (solderless) plant has now (1915) been erected.

lending as mentioned in paragraph 39, one for direct use and local inspection in the absence of a power boat; teak-built at Masulipatam or similar yards, upon working drawings to be bought in Great Britain; cost about Rs. 100 per ton for the boat fully rigged but without nets or stores. The size is somewhat above that of the "Ratnagiri" boats which come to Mangalore, but is smaller than that of many of the Bombay fishing boats in order to provide for gutting, etc., operations on board, for live-well work, and for the use of heavy nets. Boats would anchor outside the surf in the fair weather season; in the north-east monsoon they would lie up in a harbour, e.g., Madras, Krishnapatam, etc.

The working drawings can be obtained from various builders at Brixham and other South Coast ports, the Thames, Scotland, and Arklow in Ireland. The smaller class of Brixham or Ramsgate trawler, the Thames bawley boat, the Scotch "Zulu" drifter, will be convenient types on which to work. The cost of the drawings is not known, but will be arranged by correspondence now going forward.

A firm (Messrs. Parangasami) at Masulipatam can readily build the necessary boats from working drawings; this firm builds excellent and staunch boats, up to 250 tons, of teak throughout, a 55-ton boat costing between Rs. 5,000 and 6,000; these are of country fashion, but the firm can build to any specification if the drawings are provided, and will include fitting for power. The Bombay boat builders are excellent, and I may here mention a 110-foot teak yacht, fitted with a pair of Gardner oil-engines and twin screws, recently built by an Indian builder in Bombay which is giving every satisfaction to its owner.

A second-hand boat can be obtained for immediate use while the others are building.

49. *Crews.*—One crew will be needed of about six or eight men; the other will be provided by the firm co-operating with me; the monthly cost will be small and should to some extent be balanced by catches, which, however, will be partly utilized in the station.

50. *Nets and lines.*—I do not at present propose to use any but those made in the Presidency; it will be enough at first to train the crews to the use of the new boats with ordinary nets. Such for instance will be the

long drift (gill) nets of Masulipatam, somewhat enlarged from those in use inthe dinghies of that fishing port so as to suit the bigger boat and greater depths; the common "thûri" or bag net towed behind a boat (usually two catamarans) will be utilized and will gradually promote the use of the trawl; the horizontal lines with numerous hooks so common in Great Britain and found occasionally on a small scale on our West Coast, will be introduced for the capture of the dog fish and others. Several nets will be required of different mesh and for loan. The price cannot be given, but will be within a few hundred rupees.

51. *Live wells and cars.*—No attempt will be made at first to obtain boats with live wells *built into them*; chests or barrels with a small pump will be used until it is clear whether the live system can or cannot be successfully practised; moreover, live well boats are not quite so handy as ordinary boats. Live cars, for towing behind the boat during catching, will of course be tried; the expenses cannot be estimated but will be trifling.

Dead fish will be gutted, cleaned, and antiseptically treated on board the boats; see paragraph 18 *supra.*

52. *Carrier.*—As stated in paragraph 43 *supra* I do not propose to buy a separate carrier; till the inspection boat is available one of the sailers can be used to collect fish from catamarans outside of Madras with the aid either of ice or preservative methods, or a steam launch may be hired for a time, or the "Margarita" if available, may be brought up.

53. *Curing.*—In this paragraph I deal only with fish other than small sun dried fish. Beginning, as usual, with simple and known processes, I propose to open a small salting and drying yard in which the existing methods of the West and East Coasts, viz., salting—in tubs, pits, cisterns, stacks, etc.—and solar drying will be carried out with the modifications which observation in other countries and science suggest; with fish brought to the yard untainted and skilfully and rapidly treated within the yard I can produce a really good article; whether that will be acceptable to the public is a question to be thereafter answered. In this manufacture cleanliness, thoroughness, rapidity, and wholesomeness are principal desiderata, the last being, in general, the result of the first three; the first goes

without saying; the second connotes proper salting, the thorough entry of the salt into all the tissues, and thorough drying; the third is apparently inconsistent with the second and yet it is essential, and it is here that new methods come in. When fish have been thoroughly salted and washed they are laden with extra-cellular water, and when placed as at present in the open sun, not only is considerable time consumed in drying it off, but the process toasts the outside hard and leaves the inner tissues damp and a most favourable nidus for bacteria. But this extraneous moisture can be mechanically removed in ten minutes, viz., by centrifugal action; I intend to use small *manual* power centrifugals * such as are used in the United Provinces in small sugar mills, so as to dry off a few seers of fish at a time before submitting them to heat. The product will then be ready for completing by heat the cellular drying begun by the salt, and I intend to dry without that direct baking in the sun which is now practised, and to introduce the obvious methods, found everywhere except in India, of drying not on the ground but on scaffolds, wire netting trays (flakes), etc., so as to secure desiccation on both sides simultaneously. Moreover there are simple and cheap methods of heating and drying the air and of increasing the rapidity of the air currents which would take too long to describe here, but which will be detailed in a pamphlet now under preparation; by these various methods I can secure a far more rapid yet far more thorough drying than the primitive and mistaken method now adopted. The methods are based on actual practice in other countries as regards fruits, vegetables, etc., methods practised by the simplest and most ignorant farmers with the smallest of expenditure, and perfectly suited and open even to Indian curers, many of whom are well-to-do and intelligent; I have also seen some of them in use in English cod-salting yards, and in Maine, Newfoundland, Nova Scotia, etc., certain artificial drying developments are successfully practised. For these experiments little capital and expenditure will be required, but shedding and some manual machinery will be needed.

54. In this matter of drying one further step will be taken as an experiment based on the dryers which I saw

* Found to be impracticable and unnecessary.

in operation in Japan and elsewhere for fish; I allude to artificial drying. In paragraphs 40, 65 and 70 of my Japanese note I have alluded to special dryers, and wherever there is an engine artificial heat may usefully be employed by utilizing its exhaust, or, where fuel is cheap, by a simple dryer such as I have seen used for drying wet coffee, etc., or, more elaborately, in cotton mills. In Japan both methods were seen, the furnace in the second method burning any combustible rubbish; this artificial heat method is specially useful for final drying or when the air is specially moist as on the West Coast where thorough solar drying of thick tissues is often difficult. While the processes of paragraph 53 will be chiefly relied on these latter may be tried and I propose to build a couple of small cheap dryers utilizing the exhaust from any engine I may have and cheap fuel including the waste parts of fish. A small Haylock dryer costs £30 but will supply 5,000 cubic feet per minute of air at 120°-F. and would thoroughly and rapidly dry fish that a considerable yard would imperfectly dry.*

55. A combination of the special methods adopted by the Ratnagiri men at Malpe and by curers at Adirampatnam, etc., with those in vogue in England, Scotland, America and Norway is most promising; in this method salting for weeks instead of for one night is adopted, the fish being kept in heaps during the processes. In Indian practice this salting and pressing in heaps, finishes the process and the fish is then sold off; in the Western processes it is only the beginning or concomitant of slow, careful, and thorough open air drying, the result being an excellent and wholesome product. When the weather is unpropitious artifical drying of a very simple character is adopted, viz., the fish are hung in lines or placed in trays in a tall building of little cost and coke stoves introduced at the bottom; a draught is created by louvre ventilators at the top and air openings below. The western methods will be experimented upon, but no expenditure of any importance will be necessary.

56. In the matter of small fish sundried without salt, nothing at present will be done except to inculcate the drying on mats or low platforms of open bamboo work instead of on the sand, in view to minimize the admixture

* Not yet tried, exhaust steam not being available. Store dryers are in use.

of sand which, whether accidental or wilful, is spoiling a potential trade and will lead to fishery companies catching their own sardines and mackerel instead of buying the stuff which now frequently contains—according to Dr. Lehmann and a Fishery Company—above one-third of sand. The platform system would accelerate and improve drying and give no excuse for sand.

57. But omitting minor experiments as in the use of wood charcoal, etc., other processes will at once be tried, notably smoking, various methods of pickling, and canning. For smoking no apparatus beyond a cheap building will be required ; the fish after a brief period in salt will be placed in the smoke house and issued after a few hours or days according to the product required. The experiments will take the direction of the woods or substances (e.g., paddy husk) found best for the purpose, the fish best adopted for smoking, the duration of the smoking, the time that the products will keep good, and the acceptability of the goods ; Rs. 1,000 will cover the cost of building and first experiments.

The use and properties of turmeric and the acceptability of the product will specially be investigated and for this trifling expenditure will be needed.

The wet pickling of fish is a most interesting and promising process, and will be attempted at first with small barrels bought in the market of which I recently saw several cartloads, apparently from Government stores. Here the investigation will be directed to the class of fish best suited, the quantity of salt needed, the duration of salting before sale, the time during which the product will keep good, and its acceptability ; in case of success a curer-cooper from Scotland may be required but not this year ; these men from whom the Scottish Board of Fisheries draws its Inspectors are necessarily experts both in pickling and in coopering, the two industries being inseparable twins. The purchase of barrels and the building of a small open shed will be the only expenditure necessary on plant.

58. *Canning.*—I shall deal with this in a separate letter as it involves special plant, special men, and a locality where there are more cannable fish than at Madras ; there are special facts as to existing or coming canners which require special consideration. I do not propose the process, therefore, for the Ennore station.

The cost of a manual plant such as I saw in operation in Japan, both at Government institutions and in small installations, is small according to my American price lists, and I am in correspondence with British firms for further quotations which will be duly reported. But for running a cannery a special European expert, probably of the class of factory foreman, is required, since bad canned goods are very bad and dangerous.*

59. *Preservatives—Salt.*—Though the quantity of salt required may not be great it should be issued, for comparative purposes, at fish-curing yard rates, and the usual petty officers attached to the station with the proviso that such officers' duties shall not be confined to the issue of salt, but that they shall be under my orders and made both to learn and to supervise the new methods in order that they may on the one hand not be idle and on the other that they may qualify thereafter to teach in the ordinary fish-curing yards.

60. *Other preservatives.*—I propose to use certain well-known patent and other preservatives in small additions to salt according to the practice in other countries, guided by the rules laid down in the instructions issued with the preservatives, and by the authoritative suggestions of the Departmental Committee on Food preservatives. I have given reasons in paragraphs 25 and 26 *supra* for the necessity of using these innocuous preservatives which are based on boron compounds; these salts or acids are used in very small quantities, are partly volatilized by warmth, and almost, if not entirely, disappear in the processes of curing, washing, and cooking. As shown above, it is a choice between food rendered safe and wholesome by slight addition of preservatives innocuous in themselves except in large doses continuously repeated over a long period—a condition absolutely the reverse of that of the occasional consumer of small quantities of fish—, and food thrown as now on the market in a putrid or semi-putrid state, in which condition it is not merely repulsive but dangerous not so much from its bacterial contents but from the poisonous results of bacterial action. Foreign fresh herring are borated and so are many of

* Established at Calicut and very successful. A European expert was not found to be necessary.

both fresh and salted products on the European market. I propose to choose the former method, not, however, as the less of two evils, for the moderate use of preservatives is harmless, but as positively beneficial in permitting the supply of pure wholesome food not otherwise attainable, and to use slight admixtures of recognized British preservatives, with salt as a main preservative; they will be used with a light solution of salt as a wash to keep off taint when at sea, and with salt in processes demanding only a light salting; with heavy salting they are not required.

61. In studying this subject in England and Europe I found various processes in existence of which one is believed to have a large future in the food industry, viz., the new Hislaire process discovered in Belgium and patented for England by the "Universal Sterilization Company"; the system has high testimonials from bacteriologists. According to this process meat, fish, eggs, milk, etc., can be sterilized by thirty minutes exposure to a vapour in a closed chamber, the vapour being produced by pastilles of a secret formula. The goods are absolutely indistinguishable in appearance, taste, digestibility, and apparent wholesomeness from untreated goods, eggs three months old and meat several weeks old being perfectly good, and eaten habitually without the slightest ill effect. Several experiments in fish were conducted by myself in July; suffice it here to say that while in each case the control fish went bad in 24 to 36 hours, none of the treated fish, including ungutted herring, went actually bad for weeks, while several plaice were hanging up dry but *untainted* when I left in November. I propose to try this method; the expense of a sterilizer and tabloids will be about £25 delivered in Madras.*

62. A process in which the sterilizing agent is electrolysed sea-water presents the greatest promise and has the extreme advantage that absolutely no chemical or substance is added to the sea-water as a preservative, and when the energized water has done its work it reverts, *ipso facto*, but somewhat weakened, to its original condition of plain sea-water. The process will

* Not found successful in the experimental station unless slight brining preceded exposure to the vapour.

be fully explained in my pamphlet but, in brief, consists in breaking up by electricity the chloride of magnesium and some of the chloride of sodium contained in sea-water into hypochlorites which, in contact with organic matter, rapidly oxidize it; the free chlorine also acts antiseptically. The electrolysed fluid is absolutely innocuous in any shape and is handed over in quantities gratis to the poor in Poplar for personal and domestic sanitary purposes by the Sanitary and Medical officer (Dr. Alexander) who manufactures it for the municipal corporation; its effect on the most putrid substances is extraordinary. The process has not been applied in England to food products, since ice, salt, and borates, etc., are cheap and efficient, but my proposal to do so excited much interest; in France, however, where the process was discovered or first applied, the fluid (Hermitine) is largely used to sterilize meat and fish stalls and the goods in them, and is said to be most successful. A single fair experiment only was conducted in England but resulted in the perfect keeping of beefsteak for many days; the fish experiments were quite erroneously couducted, viz., by a mere momentary dipping in a weak dilution, but even so were partially successful.*

I propose to obtain an experimental plant costing £100; power is in addition required to work this, viz., a small oil-engine and dynamo, but the engine is desirable on other grounds such as fan driving, pumping, refrigerating, etc., while its exhaust will be valuable for heating. Hence, I allow for the electrolysing plant and dynamo £150, all told; the engine will be separately estimated for.

63. *Refrigeration.*—I propose to add a small (Linde ammonia) plant similar to one in a Japanese fishery station, and costing complete with storage chamber about £300 without the engine, but this may if necessary stand over till next year; its main use would be to conduct operations as they would be in a regular fresh fish business so as to ascertain its conditions, difficulties, best methods and results; it would always be saleable

* Tried with some degree of success at Ennore with fluid obtained from the Buckingham Mills by courtesy of Messrs. Binny & Co., but not followed upon the West Coast for want of plant.

if not further required. A secondary use would be to keep fish sound while waiting for treatment, so as to avoid loss by taint and unnecessary purchases from the fishermen. I can obtain this at a moment's notice when required.

64. *Mealing plant.*—Regular experiment in this process may stand over for the present, though, if opportunity offers, simple methods will be tried with inexpensive plant. I am in correspondence with a London firm regarding the process and plant found necessary in Europe, etc. I make no estimate at present.

65. *Oyster culture.*—For the current year operations will be confined to observation and the selection of a site or sites and their acquirement, and expenditure is hardly expected unless for obtaining and protecting the areas ; if time permits, cleaning operations may be begun and spat-collectors placed in position.*

66. *Pearl button plant.*—I have not as yet procured this plant, but am corresponding in view to obtaining it. It is not generally known that pearl shell, a by-product of the pearl fisheries, is exported from Ceylon in enormous quantities every year ; in 1906 the export was 13,800 cwt., of which Germany took more than half, Japan about 1,150 cwt. and Great Britain only 922 cwt. ; in ten months of 1907 the exports were 10,575 cwt., of which Germany took 7,002. These are for common pearl button-making, and of course only perfect shells are worth sending ; allowing for breakages and useless portions possibly half of the weight of the shell sent is actually utilised for button-making, so that freight and other charges are paid on a mass of useless material. The shells are sent in bags or wooden cases ; if sent in bags the packing cost is less than if in cases, but breakage is considerable. But it actually pays to send pearl oyster shell to, say, Germany and the United States of America, to pay cost of packing, freight, breakage, agency charges, etc., and to work them up by expensive labour into cheap pearl buttons which are again sent out here for sale.

* There is now a successful though experimental oyster farm at Pulicat, established and run by Mr. James Hornell, Marine Biologist and Assistant in the department.

This is one of the absurdities or scandals of Indian industry ; there is little enterprise, knowledge, or capital needed to start this business in India (or Ceylon) and to save all the intermediate costs while promoting a new industry which ought not merely to supply India, but Europe, with buttons. In the case of India a supply of shell, when our own supplies are exhausted, could be brought over to Tuticorin, Pamban, etc., by native craft at minimum cost especially by Kilakarai boats returning from pearl fishing, and it is to be noted that whereas only perfect shell can be sent to Europe, there are millions of less perfect or partly broken shells which are perfectly available for working up on the spot.

Hence I propose to get a set of tools this year, to set up an experimental plant at Ennore in order to train a few workmen, and then to transplant the business to Tuticorin or Pamban, unless, which is probable, some indigenous firm buys the plant from us and takes over the enterprise which is one of a very simple mechanical nature. I place the maximum cost at Rs. 1,000.

The methods are well known and simple and I do not think that the importation of an expert is necessary ; success can be obtained by expenditure on experiment until experience has taught the precise methods for the class of shell. But, if necessary, I shall arrange to send a man to Europe to learn the business or, possibly, I can obtain a Bengal man who has been taught in Japan.*

67. *Inspection boat.*—This it will be remembered (see paragraph 43) is to serve for inspection, experimental fishing (trawling, etc.), simple research, and carrier work. The " Margarita " is not a very satisfactory paddle boat, is hardly suitable, and seldom available just when required, as the pearl oyster work detains her in the fair weather ; e.g. I applied for her this March and could not have her, while in January and February she is usually needed for inspections ; moreover she is large and costly to run, and not well suited for trawling or drifting experiments. The "Irene" would, if fitted with auxiliary power, have suited me very well, being well built and comfortable ; two years ago I enquired through the Port

* Hitherto button manufacture has, for various reasons, mainly the unsuitability of our shells, been found impracticable.

officer of Tuticorin as to the cost of fitting her with kerosine engines, but the need for her was not then clear and the matter dropped; I now hear to my great regret that she has been sold out of the service. Eventually therefore I hope that Government will provide a somewhat bigger boat than the "Irene" fitted with auxiliary power (probably kerosine engines) and with all the necessary appliances for experimental fishing and the preserving of fish, such as trawls and other nets, dredges, fish hold, ice room, net and warp rooms and the usual mechanical aids to hauling heavy nets and lines, together with accommodation for the experimenter or observer. As she will be a good power boat she could, if not required after serving her early purposes, be sold at a good price. A boat for our purposes does not require to be very large or of great strength; ours are fair weather seas and all operations would be in fair weather; we are not liable to sudden storms and our range of work would never be more than a few miles from shore; hence steamers such as are required in Great Britain where voyages, e.g. by the "Huxley" research boat, are undertaken as far as Iceland and even the White Sea, and where the most violent weather may be experienced at any time, are not needed; on the other hand, tropical conditions require certain protection and comfort, and if trawling and other netting experiments are to be carried out the boat must be staunch and strong; for use as an experimental carrier she must have a speed, of, say, 7 or 8 knots. I enquired of many firms in Great Britain on my recent visit and also consulted the Irish and Scottish official authorities, and if Government choose to incur the expense, a very useful full rigged boat with a "Dan" or other kerosine engine as auxiliary, and suitable for all fishery work, could be obtained fully fitted for about £2,000. For reference and as an illustration only of general type, I enclose drawings and a description of such a boat ("Ibis III") and copy of a letter from Messrs. Linton Hope & Co., the well-known naval architects and marine engineers; first class trawler and fishing boat builders in Grimsby, North Shields, Glasgow, etc., has also given rough estimates and will be prepared to quote on demand.

From information obtained out here from Mr. Scovell and others it would, if such a vessel is sanctioned, be well to purchase the design and drawing from a British firm and have the boat built in Bombay or other port, the engine and special fittings being supplied by the same firm that supplies the drawing; this would be a cheaper plan and would avoid the great cost of bringing such a boat out.

68. I shall be glad if Government will pass specific orders on this question, viz., whether they will be prepared, on application, to provide a boat somewhat similar to, but smaller and less highly fitted than "Ibis III," to cost ready for sea not more than Rs. 30,000 delivered at a port in this Presidency, including the cost of nets, lines, any special industrial apparatus, and appliances for scientific observation.

Staff.

69. *Working establishments.*—One additional reason for simple beginnings is that at present we have no expert staff and must work with what we can find. It will be seen from paragraphs 47 to 66 that there is nothing—except as regards canning, excluded for the present—which cannot be carried out by the intelligent direction and supervision of men available in the country.

As regards *boats*; the fishermen of the coast unlike the men whom the Irish Congested Districts Board are endeavouring to turn into deep sea fishermen, are thoroughly acquainted with, and live on, the sea and many of them are already expert sailors accustomed to sail coasters from our ports to Ceylon and elsewhere, or smaller boats such as the Muttupet and Pamban dhonies, the Masulipatam dinghies, etc.; many of them are ready to man large boats if provided. Hence I can easily get serangs and crews of fishermen to handle these boats which though larger will be of simple rig to which the coast sailors are accustomed. Similarly these men will handle nets of their own customary patterns, the only difference being that they will be used further out at sea and will be heavier and longer; these are but slight modifications and the winches on these boats will

more than countervail any extra weight. The long lines are, on this coast, a novelty but are perfectly simple in use and a couple of men will be sent over to the West Coast to learn their use as well as other catching methods, and British modifications will then be added. As mentioned in paragraph 68, I hope to get men trained at Calcutta in trawling methods. As for the gutting and cleaning operations on board they will be only those which are carried out on land with the antiseptic additions suggested by knowledge. The live-well, chest, or car, will be purely novelties but so simple that a child can learn and practise their use; they will not even need inculcation or instruction as they will commend themselves at a glance.

I propose then after obtaining the necessary boats to appoint a boat crew whom I will select from Madras boat and fishermen with a serang accustomed to the class of boat; the crew of the second boat will, of course, be selected (and paid) by the co-operating firm of whom I have spoken. For the petrol or paraffin dinghy one engine hand will be needed who can be obtained in Madras.

70. As regards *curing*; this is a current industry, as regards salting and drying, all round our coasts, and it will be easy to draw two or three men from, say, Adirāmpatam (where there is more varied curing than elsewhere) to start operations. These will be instructed, with local men, in the ideas and methods which it is sought to introduce, and a couple of the more intelligent will be taken with a Sub-assistant next November or December to learn West Coast methods, especially at Malpé where the Ratnagiri men work.

Similar men will be selected to carry out, under my own or Assistant's supervision, such further developments as I have indicated in matters of drying, smoking, wet salting, the use of turmeric, the application of preservatives and preservative methods; there is nothing that cannot be here carried out without special experts, except a special hand for the electrolyser for whom application will be made to the Madras Electric Works. A couple of oil-engine hands will also be needed; these can easily be obtained in Madras.

71. *Inspection boat.*—I am unable to say at present what staff will be required for this, if sanctioned ; it will be less than that required for the comparatively large "Margarita" (Rs. 500 per mensem) which, moreover, is engined with steam. But during voyages a competent skipper will be needed, say, for six months from November to April ; possibly a junior Port officer might be available.

72. *Superior staff.*—For general purposes, and more especially for the supervision under my direct personal control, of the experimental station including the developments which will follow in the shape of branch or other stations at Tuticorin, Tellicherry, etc. I need a trustworthy and competent Assistant, one not too young, genuinely interested in and having first-hand knowledge of fishery work on the *industrial* side, and capable of going abroad, e.g., to England if required. Such an officer (an Indian) I have in my mind and will address Government separately regarding him.* By competent I do not mean "expert," for I know of none such in India, but a man of education, common sense, intelligence and energy ; one who will readily grasp principles and the methods based on them, and capable of modifying existing methods to suit new ideas. The sanctioned post of Personal Assistant is now vacant ; the pay would be that already passed by Government, viz., Rs. 175—5—200. I need also a Sub-Assistant on Rs. 50—5—75 as sanctioned for immediate charge of the station, and would appoint a man from the West Coast who is already accustomed to, or acquainted with, fishery work.

I do not at present suggest any further appointments as regards the work now in question, as the canning station and plant must lie over pending separate reference and orders.

Cost.

73. It is impossible to state the exact cost of plant and staff until correspondence with firms is concluded and the staff actually worked out. Approximately it should be something as follows :—

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* Subsequently appointed ; he is now (1915) Assistant Director.

	RS.
(1) Two 15-ton boats complete at Rs. 100 per ton *plus* cost of various working drawings from England and stores	3,500
(2) Nets, lines, live chests, for one boat only, the other being provided by the co-operating firm.	1,000
(3) One 16 or 18 ft. dinghy from America, landed and set up in Madras, complete with 2 H.P. petrol engine, as per catalogue	500
(4) Drying plant, viz., air heater and fan (500), drying closets (200), manual centrifugal (200); altogether say	1,000
(5) Salting tubs and cisterns, drying platforms, and scaffolds; all simple and cheap	100
(6) Preserving plant, viz., Universal Sterilizer landed in Madras (Rs. 400), smoke shed (100), barrels (200), stock of preservatives (500), experimental electrolyser and dynamo, etc. (2,500) ...	3,700
(7) 3 to 4 B.H.P. oil-engine, oil tanks, etc. ...	1,500
(8) Windmill, pump, and tank	1,500
(9) Set of pearl button tools	1,000
(10) Shedding, engine, etc., foundations, and drying grounds necessary for above; shedding of small area and very simple, for engine, electrolyser, and drying plant only	1,000
Add for contingencies, repairs to Ennore bungalow, superintendence	2,700
Grand Total ...	17,500

I have not included the cost of an oyster culture ground, as the expenditure on this will hardly come into the current year, but it will not be considerable at any time.

The cost of a refrigerating and canning plant is not included; the former as quoted for, would cost £275 f.o.b. in London, to which must be added freight, charges, and building. I do not intend to ask for this at present, but it may be required shortly in connection with fresh fish experiments or a canning plant since it would keep tons of fish in perfect order, while waiting to be sold or canned.

A canning plant of the size mentioned would cost, according to lists, about the same, as the machines are simple and cheap, if open brine boilers are used; if a steam boiler and cookers as per modern processes are installed, the price would be increased. I am reporting separately on the whole canning question.

The cost of an inspection boat is not included, since it is not known whether she will be sanctioned or her precise cost if sanctioned.

74. To the above capital cost of Rs. 17,500 for plant must be added running cost, viz., establishment, oil for engine, salt, wear and tear of nets, a little wood fuel for dryers and smoke house, the upkeep of the small petrol dinghy, and so forth.

Hence the running cost of the Experimental Station for the current year, exclusive of the inspection boat and of the supervising staff, should be about Rs. 6,000 *plus* a share of the cost of the "Margarita," and for this and for the capital cost (Rs. 17,500) sanction is requested. Further sanctions, e.g., for the inspection boat, canning and, perhaps, refrigerating plant, will be subsequently requested. The running cost of two Japanese stations that I visited was Rs. 27,385 and Rs. 14,122 respectively for 1905; in neither case was there any power boat, but both had canning plants and one a cultural branch.

75. *Resume.*—An abstract of the above letter is as follows; postulating that abundant, cheap, and wholesome fish food for the masses is the object aimed at, it advocates deep sea fishing not by means of steam trawlers or expensive modern plant but by sailing boats of moderate size, large enough to go far to sea, to use better catching plant, to treat the fish hygienically at sea or to keep them alive in wells, chests, or cars, and yet to be within the purchasing power of individuals or small groups; small power-boats as carriers to ensure the delivery of live or sound fish at shore are also advocated and even the use of auxiliary power—probably in the shape of *kerosine* engines—for catching boats is suggested in special cases, as to supply a fresh fish market, a canning factory, etc. These will be the objects kept in view in the experiments conducted *at sea*. *On shore* the treatment of the fish by improved preservative methods, including the use of preservatives new to Indian industry, though not new elsewhere, and of processes not at present practised such as pickling, smoking, etc., will be the subject of varied and continuous experiment. In all the above matters the interest and co-operation of the public will be invoked, especially that of firms and

individuals connected with the trade who have already promised assistance.

For the above, an experimental station at Ennore is to be started on the site granted by Government in the Public Works Department, Ennore being selected for the reasons given in paragraph 46. A branch will be suggested for canning and general curing purposes, probably at Tellicherry where suitable fish are abundant and curers progressive and enquiring.

The plant necessary is summarised in paragraph 47, the probable first cost (Rs. 17,500 exclusive of an inspection boat, canning and refrigerating plant) in paragraph 73, and the current year's running cost (Rs. 6,000 inclusive of working establishment but exclusive of supervising staff, paragraph 72 and cost of an inspection boat, paragraphs 71 and 74) in paragraph 74.

Separate letters will be sent regarding an Assistant and a branch canning station.

ORDER—No. 1635, REVENUE, DATED 12TH JUNE 1908.

The Government approve generally of the lines on which Sir F. Nicholson proposes to proceed in the experimental development of marine fisheries in the Madras Presidency.

2. The proposal to locate the first experimental fishery station at Ennore on the East Coast instead of at Tellicherry on the West Coast is accepted and sanction is accorded for an expenditure of about Rs. 23,500 in the purchase and erection of the required plant and towards the cost of the station during the current year.*

3. The Government understand that Sir F. Nicholson does not need at present the inspection boat mentioned in paragraphs 67 and 68 of his letter, that the services of the "Margarita" will, if possible, be utilized for inspection and experimental trawling during the current year, and that one of the big boats to be purchased will be used both as a carrier and as a fishing boat. Orders on paragraph 68 of the letter will accordingly be deferred for the present.

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* Ennore was soon found to be unsuitable and the experimental station was transferred to Cannanore; see page 160 below. Very slight expenditure was incurred at Ennore.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., I.C.S., Honorary Director, Madras Fisheries, Madras
Dated—the 13th July 1908.

I desire to make suggestions on the sardine trade of the West Coast. From Coondapoor to Cochin, especially in certain areas, the beach is frequently covered between October and February with these fish drying in the sun ; they are intended chiefly as manure for which they are most valuable (see paragraphs 100 to 106 of my note on Japanese Agriculture) ; roughly the "whole" fish contain 10 per cent. nitrogen and 4 to 5 per cent. phosphoric acid, besides other constituents.

2. Putting mackerel out of consideration for the present, though in the seven years ending 1906 the fish-curing yards received on an average 369,100 Imperial maunds of mackerel against 182,930 maunds (6,755 tons) of sardine or exactly double, attention will be confined to sardine, and that chiefly in the way of exports as fertilizer. For it is to the loss to India both as food, manure, money, and trade that I desire attention. So far as the above 6,775 tons of cured sardine are concerned I have obviously no complaint since the whole of this is used as food and much of it in this country. So also with regard to the comparatively few tons of fertiliser used on our tea and coffee estates, all of which directly enrich the country. But the fertiliser trade is a very grave loss to this Presidency.

3. I am not as yet able to give exact figures for this business ; I am gathering them from the statistics of the seaports and can give minima, though the precise figures are not of supreme importance since it is admitted that the lowest figures are very large. For 1907–08 when sardines were unusually abundant, the exports of fish fertilizer from the Malabar district alone were 11,527 tons to Ceylon and 3,302 tons to Japan or 14,829 tons ; these two countries took all the foreign exports. In the previous year when sardines were ordinarily abundant the exports to these two countries were 4,580 and 1,142 tons, respectively, or 5,722 in all. The above figures are minima for Malabar district ; in reality the exports were slightly greater, but are not distinguishable from inter-coastal trade. The figures for South Canara will

be added when received. Fifteen thousand tons of sardine dried for manure represent at least 30,000 tons of fresh fish averaging large, medium, and small sardine at 45,000 per ton, this means at least 1,350,000,000 fish.*

4. My point is this; at present this enormous amount of potential food—either direct food if eaten as fish, or indirect if used as manure for cereals, etc.—is lost to the country *qua* food; the money proceeds as received by the fishermen and local agents, are much too low; while the export of this mass of merely dried fish deprives the country of a large industry in the preparation of the fish either as good food or as good manure and oil, and in the sending of it through and into the country. The whole business as it is at present and as it seems likely to be conducted is a conspicuous example, as is also the sister trade in oil seeds, of unnecessary and vexatious loss to the country. I blame no one; I state the fact; I propose some small remedial measures.

5. It will be observed that I am obtaining statistics of the dried sardine fertilizer trade through the Sea Customs officers. That is because the great bulk is *sent out of the country*. Small quantities are dried and sent to Mysore, to the tea estates on the Nilgiris, and to the Shevaroys, etc.; a little is occasionally used, more often the guts, for cocoanuts, tobacco, cucumbers, etc., on the coast, but, as shown above, the great bulk goes abroad, either to Ceylon for the tea estates there, or for re-export to Japan. In my note on Japanese Agriculture I have shown not only the enormous and increasing demand in Japan where they already use a minimum of 134,000 tons annually; but the price, which there ranges between Rs. 110 (wholesale) and Rs. 150 (retail) per ton for this fertilizer, chiefly as scrap or dried fish *minus* its oil, is a sufficient proof of its productive value. As shown in that note, one ton of well-dried whole fish fertilizer free from adulterants such as sand, contains 224 lb. nitrogen and 90 of phosphoric acid, or 10 and 4 units, respectively; these are the nitrogen and phosphoric acid contents of 9,000 lb. of grain, and 12,500 lb. of straw; in other words, it would suffice for 20 acres of dry cultivation as

* The total average exports are much larger; in one recent year they were 34,000 tons, representing 85,000 tons of fresh fish.

an addition to present manures. Hence, if the 15,000 tons of dried fish now exported were used in this country, it would well suffice for 300,000 acres, and should produce, at three fourths of its nominal fertilizing capacity, above 100 million pounds of grain, and 135 million pounds of straw.*

6. Why does this enormous amount of potential food leave this country? Simply because its productive value is not recognized. Why is its value not recognized? Because there is no proper organization either properly to prepare and put the stuff on the market *as food*, or to explain its value and push its use as a *fertiltzer*. It is far easier for Indian merchants and agents to buy it upon commission and sell it on the spot to firms who will ship it off to some country where the foreign tea planter or export merchant will utilize it, than to take it up-country and sell it either as dried food or as manure. It will be said that trade and industry always seek the line of least resistance; they take the easiest opening. This is so; but if this line is damaging to the country or even less productive than it should be, it is for us to see whether a better line cannot be opened. It is largely a question of knowledge, enterprise, push, organization, and I now propose to stimulate and help these factors of good business, and to assist in creating both a desirable product and a demand.

7. What is the actual loss to the country? We lose the fish altogether both as food and as manure; we gain *not* its (Japanese) sale value but only a fraction of it. I found the price in Japanese ports to be about Rs. 110 in bond; 70 yen or Rs. 107 was recently mentioned to me in India as the ordinary price obtained in Japan. Now this country does not get that sum even approximately; the fishermen who catch and dry the fish get an average of from Rs. 8 to 10 per ton for the wet fish or Rs. 18 to 25 for the dried; on an average Rs. 20 to 22 per ton of dry fish. The brokers who buy from them and sell to contractors get a rupee or two per ton, and the contractors get their profit from the exporting firms usually, if not always, European; it is said that a ton of dried sardines free of sand costs

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* See last footnote.

European firms about Rs. 30, a 20 per cent. deduction being made for sand. To this must be added a small cost for carriage to Ceylon and the agency charges there, except when the stuff is sent, as is now largely the case, direct to Japan. Obviously, allowing largely for local charges, freight, etc., there is a very large margin between Rs. 30 in Calicut or Cochin and Rs. 110 in Japan. Hence while the export trade obtains a maximum of profit with a minimum of labour and expense, and the actual fishermen and local agents a minimum share of the sale value, the country loses the whole of the stuff itself.

8. We have here an important contrast; on the one hand our sardines bring us in a money value of perhaps Rs. 35 per ton of dried fish as the *total* result of our sardine harvest; on the other, if we, i.e., the public, kept the fish in the country and either ate it or put it on the fields, we should, (1) as at present, provide the Indian fishermen with about Rs. 22 to Rs. 25 per ton of dry fish; (2) as at present, the Indian commission agents would get perhaps Rs. 5 per ton; (3) if the fish were used as food, we should provide a large body of curers and operatives with a livelihood; (4) we should largely help in maintaining communications and those who live by them; (5) we should provide work and profit for a body of wholesale and retail dealers; (6) we should keep a vast mass of food in the country. If used as fertilizer we should (3) introduce a valuable industry in the way of expressing fish oil and preparing fish fertilizer from the scrap, an industry requiring only moderate plant and technical skill; * (4) we should utilise the oil in batching jute, in the leather trade, and otherwise; (5) we should help to maintain communications in sending the stuff up-country; (6) we should have a vast mass of the finest manure for our fields and a consequent vast addition to our food-crops; (7) we should provide work and profit for a number of dealers and for our co-operative agricultural associations. If, again, our peasants would learn the true use and disposal of human excreta, these fish after *first* being used as food and doing work as such, would pass into the fields as the

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* Since introduced: in 1914 above 200 small factories were at work along the coasts of Malabar and South Canara.

greatly enriched excreta of the human consumer, thus bringing about the natural circulation of food, fertilizer, and again food, and so *ad infinitum*. On the one hand a few rupees and a minimum of industry, on the other hand stimulated industry and trade, the whole value kept in the country, and a vast addition to the food-supply direct, or indirect, or both.

I propose then to take up the sardine industry of the West Coast, partly by direct work, partly by stimulating Indian traders and industrials.

9. *Fertilizer.*—I do not propose to enter into the manufacture of fertilizer ;* it would involve heavy plant and expenditure, and a Cochin (London) firm is already experimenting on a large and modern scale, viz., in expressing the oil, in selling this to traders that need it, and in selling the scrap ; they are willing, of course, to sell in India if they can get an equally profitable market, and the head of the firm would prefer to do so, as involving less trouble, but, of course, he looks to the best market. Fish scrap fertilizer, i.e., dried fish free from oil, is now, I believe, available to some extent at Cochin, but it is probable that within one or two years a very large amount will be on sale and, if profitable, the business will probably be imitated by competitors; hence there is no need for Government in the Fisheries department to interfere in this manufacturing branch of the matter. But I consider that the use of the stuff may be pushed in the Agricultural department and especially, at the outset, in the Coimbatore district, which, being full of comparatively advanced and pushing agriculturists (Goundans) with many valuable industrial crops under wells, in close proximity to the West Coast, and possessing an Agricultural College and experimental station, should be a peculiarly suitable district for experiment. A few tons of *scrap* fertilizer, i.e., not the crude fish but the residue after expression of the oil, distributed gratis to a number of selected ryots, under conditions and instructions as to use, might be well spent. Where there is a practical agricultural association with real working life in it, a ton or so might be handed over for distribution among the most intelligent members, conditioned on careful supervision

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* This was modified next month by proposals for a small oil and guano factory which was, in fact, established within three months ; see next following paper.

and report of results; papers might be drawn up in the department detailing the importance of the manure and its successful use in every other country, and, when results permit, its success in this. Substantial prizes might be offered to successful users; not a rupee or two for a sample of grain or produce, but Rs. 20 or 25 for a crop *on the field*, of an area of, say, $\frac{1}{2}$ or 1 acre. Long ago, and often since up to 1907, I have advocated the use of the prize-field system; originally and in detail in my letters read in Board's Proceedings No. 214 of the 13th July 1887, in paragraph 98 of my note to the Agricultural Committee of 1889 who adopted the suggestion in paragraph 53 of their report; later on in my memorandum of 1st November 1899, and finally in a note to paragraph 175 of my note on Japanese Agriculture; my visit to Japan has indeed strengthened my views as the system is in vogue there; see paragraphs 175 (1), (11), (12), (16), 180 (2), 182, 184 (3) and (6), etc.; moreover the Irish Agricultural Department has recently re-adopted and is now working this stimulative method; in Denmark it is largely employed through the local societies. I presume it has never been tried in this country because of the want of judges and of funds; if the new Agricultural Associations are worth anything, judges ought now to be available—with departmental help—for so simple a matter as judging the success or not of a field crop, growing with a particular manure amidst similar unmanured crops. As for money, much is not required for experiment; personally I shall be happy to give Rs. 500 per annum for three years as prizes in the Agricultural Department for field crops grown with fish scrap fertilizer in the Coimbatore district and within a small typical area which can be properly supervised and judged. It goes without saying that the fertiliser will be exhaustively tried in the Coimbatore Agricultural Institution, but I see no reason why ryots should not be invited to try it at once on certain selected crops, in selected cultivation seasons, and in a selected area. If the ryot will but take to fish fertilizer as a rich and necessary manure, we shall at least keep the product of our sea harvests in our own country, so that both fishermen, ryots, middlemen, industry, and transport will reap the benefits.

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10. *Food.*—As for the food question. It is, of course, hopeless to think of putting fresh sardines on an inland market; they can only appear there as a cured product, either dried, dried and smoked, salted, or canned. Hence I propose that an experimental station at or near Tellicherry should be opened in two sections as soon as possible, primarily for work at the sardine and mackerel shoals:—

Section 1	...	(1) by way of improving the ordinary salting and drying,
		(2) by adding smoking to the drying,
Section 2	...	(3) by canning.

Experiment, especially in smoking and canning, will also be carried on with several other classes of fish.

11. *Section* 1.—At various places I saw a good deal of the sardines as "cured" for food; in the better class of methods as at the fish-curing yards, they were lightly salted (one part salt to 7 or 8 of gutted fish) for one night, rapidly dried on the ground in the sun for a day or possibly two, and then sent out for consumption. A large quantity, however, was either slightly salted in domestic yards and dried, or dried without any salt at all, and the product was then peculiarly offensive; at certain railway stations the packages simply reeked with taint, or "high" flavour, and were for despatch to the East Coast (South Arcot especially) where sardines do not appear. Now properly cured sardines are excellent and cheap food and I propose first to experiment in securing that the fish shall be absolutely fresh on arrival at the yard; this is easy at present as the fish are caught inshore, mostly within 2 or 3 miles of the coast, but when fishing extends further out the motor or steam carrier may become necessary; the live chest or pen near shore in which catches not immediately curable may be retained alive will also be tried. I propose, secondly, to cure them in several different ways; (*a*) they will be treated as pilchards are treated in Cornwall. From October onwards when sardines and mackerel are most abundant on the West Coast, they are also fat and full of oil like pilchards; they can be then mixed with plenty of salt heaped into vats provided with means for allowing the brine and oil to escape, somewhat weighted, and left for several weeks (if necessary) in the vats; they are then taken out washed, packed, and marketed; (*b*) they

will be salted both lightly and heavily, and sun-dried by an improved process; (*c*) they will be brined or salted lightly and heavily, partially sun-dried, and then smoked for various periods and at various temperatures. A site will, if Government approves of the proposal, be at once selected, an estimate submitted, and work begun by 1st October.

12. *Section* 2.—But an important function of the sardine is to be *canned*, and to judge by the appearance of the fish themselves and by results obtained at Mahe, our sardines are admirably adapted to fill this function. Perhaps the very first attempt at progress in Japan was in canning sardine (paragraphs 151, 40, etc., of my Japanese Note), and the goods which I obtained there were excellent and cheap; the small ones were the best I have ever tasted. The Japanese are now endeavouring to enter the highest priced markets of the world, e.g., the American—by improving their goods in every way; the best oil is imported and a complete rebate given of the import duty when canned goods in oil are exported. Not only so, but they can these fish in various ways especially for home consumption, as by simply canning the fat fish in large cans (of 4 lb. or larger); the export goods were seen not only in Japan but at European exhibitions such as that of Milan, while the domestic goods were seen and tasted at the Japanese Experimental station and at private factories; these latter included large tins in which the fish were simply boiled in their own fat which is found as a cake on the surface when the air-tight tins were opened. The *wholesale* prices—see table in paragraph 165 of the Japanese Note—varied from Rs. 15 to Rs. 18 per case of 100 quarter tins delivered at Kobe, or about 2½ to nearly 3 annas per quarter tin.

Now we have three excellent sardines, besides the Engraulis, on the West Coast; these spawn in June-July, and by October when they are more largely caught, have become fat; they are then admirably adapted for canning; nothing is required but the factory and the expert. As for price, the solitary French canner to be presently mentioned, sells his goods at Rs. 11 to Rs. 12–8–0 per case of 100 ordinary quarter tins, and at Rs. 15–10–0 for key-opening tins, or 0–1–9, 0–2–0, and 0–2–6 per tin. These are excellent goods, and since

the manufacturer is able to make a living profit on a small business, it is clear that we can do better than even Japanese prices which, again, are lower than ordinary European prices. I propose then to develop this business both for export and for domestic trade.

13. I propose then a cannery near Tellichery * which is a great sardine centre; there is a French canner of Mahe who operates in British territory close to Tellicherry, and instead of competing with him I hope to co-operate with him. Canning is a delicate operation; toxic products are more probable and more virulent in badly canned fish than elsewhere, possibly for the reason that it is the most toxic in the early stages of decay and becomes less so as decomposition develops; hence when slightly decomposed fish are canned, decay is stopped but the virulent toxic elements may remain, especially if the cans have not been heated well above boiling point, say 240° F. to 250° F. under 10 or 15 lb. steam. Similarly, if perfectly good fish are not thoroughly sterilised by good processing, decay may slowly develop and with it the peculiar toxic elements of decomposition. Hence canning must not be introduced except under thoroughly expert instruction, for which purpose it will be necessary either to employ a first-class foreman from an English firm, or to use the man on the spot who is not only an expert producing good and cheap goods, but is well acquainted with the seasons and classes of fish, with the local people and market, and with the peculiar conditions of tropical canning. I send herewith some specimens of his canning; I have frequently eaten his goods and believe them to be safe, because he cans only on a small scale, with fish caught close to the factory, while the processes are carried out either by himself or under his immediate inspection. Hence I would recommend co-operation with this canner if he will come to terms, Government granting certain substantial advantages in the way of modern plant and salary, in return for the thorough training of apprentices in all the methods of canning. The canner will, of course, derive great advantages from this co-operation of the Government,

* For various reasons the cannery was not opened in this neighbourhood but was set up temporarily in Calicut as a purely departmental enterprise, at the end of 1911 and began work in January 1912. Nor were the services of the French canner (M. Josselin, since deceased) availed of.

since he will obtain at least a salary (equal to substantial premia) for teaching our apprentices, and probably a Government loan either in the shape of plant or money, together with a guarantee that Government will not itself promote or aid competitive factories within (five) miles on either side of him. If he declines to co-operate there will remain the alternatives that Government must open its own canning factory and school wherever it may be convenient, or will endeavour to co-operate with some other firm. I submit a general idea of this canner's work and of the conditions I would propose in a confidential appendix to this letter, and should Government approve of the idea will open negotiations.

14. In drawing up proposals I have, as regards plant contemplated three alternatives; (*a*) the provision by Government of modern plant both for can-making and canning, and for the *lending* of such plant to the canner *gratis* in return for full instruction in the use of it; (*b*) the loan of funds to the canner who could then provide his own plant; (*c*) the simple training of our apprentices by the canner in his existing methods and with his existing plant. As regards (*a*) there are the difficulties that we should have all the trouble and delay of choosing and buying the plant, and that after all it might not suit French methods or ideas; also that he might use it carelessly and recklessly, as not being his own, and that there might be endless disputes both as to the wear and tear of the plant and as to the liability for any repairs that might be needed; this would be accentuated as the three years' term came to an end. I mention three years, for that term should suffice to train up a dozen or more men who will serve as instructors and experts to private enterprise or in Government installations, and the arrangement might then terminate.

As regards (*b*); here Government would, like the Congested District Boards in Ireland, simply lend the canner such sum, say Rs. 6,500 (see *infra* paragraph 19), as would enable him to buy the proper plant, in the selection of which Government should claim a voice so that we may ensure good machines for modern processes; this sum might be lent free of interest for three years and thereafter at 3 per cent. for another four years when it should be recoverable, and it would be secured by a

mortgage on the factory. In this way Government would be spared all disputes and complications and the canner would naturally take good care of his own property.

As regards (*c*) it is known that this canner is working by ordinary French (Brittany) methods and does not use steam pressure cookers but simple, open brine baths; hence he may be unable to instruct in the use of the more modern plant which, however, is desirable for many reasons, and must eventually be worked up to. It is believed also that his sardine tins are sent out from France ready cut and shaped but in the flat, so that he has nothing to do but solder the tins up and affix the labels which are also imported.

15. Canning plant is by no means expensive. For can-making the manual or foot power machines are simple and comparatively cheap; one American list works out at £80 f.o.b. for plant for 2 lb. and 3 lb. cans, to which must be added the dies (£8) required for sardine cans; £110 should suffice to land a full plant on the West Coast. A London firm quotes me a small manual plant for round and sardine tins for £75 f.o.b. and less 5 per cent. discount, and I should recommend this offer if a plant is needed, as it could be landed for less than £100.

As regards canning plant; by a printed American price list machinery for 5,000 round cans (2 lb. and 3 lb.) per day with steam boiler, scalding and exhaust tanks, one steam pressure processor, and many etceteras, should cost about £140 f.o.b. From correspondence with London firms this is about the mark, the chief items being a vertical self-contained steel boiler complete with steam fittings (£50 to £60), a steam processor also complete (£50 to £60), an open boiler, steam heated (£10 to £12), and etceteras; one firm offers the goods at these rates f.o.b. and less 5 per cent. discount. Hence £200 should see a small but good modern plant delivered on the West Coast. Of course, it is possible to can as the French canner does, with mere open brine baths over furnaces, in which case a few hundred rupees would be ample for the actual canning plant. But as stated above, I strongly recommend processing under steam pressure at a temperature of say 240° F. as against the cheaper and easier open (brine) bath system; it is far safer as

regards the products, for in the brine bath the internal temperature of the cans cannot be raised above 212° without danger of their bursting, whereas in the steam cookers the pressure of the external steam balances that from within, so that higher temperatures up to, say, 255° F. can be reached with perfect safety and with consequent inestimable advantages to the quality of the goods. For sardines *in oil* open baths may be used and will be tried, but the steam cooker is necessary for general goods. Moreover, it is desirable to take a step in advance, and not to be content with open, low temperature baths, but to introduce modern methods which are at the same time more rapid and more safe than the old ones. More rapid, for with a steam heat in the processor of 240° or 250° F. the goods are processed in half the time required in open baths at 212° F., with consequent great saving of fuel and with the ability to deal with double the number of cans and double the amount of fish in the same time, a matter of the first importance in this climate. More safe also, as explained above in this paragraph. At the same time the open bath system will be in use so that small capitalists may utilise the simple and (initially) cheaper system.

Hence the total cost of plant for both can-making and canning should not exceed £300 delivered on the West Coast, to which would have to be added the cost of the very simple buildings required and of etceteras bought locally.*

16. A motor boat as carrier, costing perhaps Rs. 3,000, will also probably be necessary in the near future, but this may stand over till next year when work develops; without such boat it might be difficult to bring in a sufficiency of fish in a perfectly fresh state to keep the factory at work, since the sardines are capricious in their visits both as to time and locality; moreover when the fishing extends to off-shore areas, a motor boat will be necessary to bring the fish in rapidly. The Mahe canner recently bought a kerosine motor boat, but it is said to lack power and size and to be therefore unsuccessful.

17. So also it may be found advisable to obtain a small Linde ammonia refrigerating plant, costing about

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* A small plant on the above lines was accordingly bought and eventually put in operation (see previous footnote), with such success that a larger "sanitary can" (solderless) plant has now (1915) been set up at Beypore and will start work in August.

£300, * in order to ensure the keeping a stock of fish free from taint for some days so as to maintain several days' supply of fish in perfect order ; at present fish go bad within 24 hours so that the factory must stop work whenever fish are not caught in the immediate vicinity. For a similar reason floating chests or pens for live sardine may be hereafter advisable. But these items may also stand over till next year, and are only mentioned so that the *whole* probable cost may be roughly estimated from the beginning and that Government may know what expenditure is contemplated.†

* A smaller refrigerating plant, costing with oil engine completed, under £150 has been obtained and set up (1915) at Beypore where it should be at work by June.

† The above proposals were all sanctioned by the Government of Madras in G.O. 2267, Revenue, of the 17th August 1908, with the suggestion that failing successful negotiations with M. Josselin, an independent Government cannery should be arranged for. Negotiations, however, for various reasons, especially the pressure of other work, were not attempted and eventually a Government cannery was opened.

ORDER—NO. 2267, REVENUE, DATED 17TH AUGUST 1908.

* * *

2. The Government agree with Sir F. Nicholson that every endeavour should be made to make more widely known the value of fish manure and to extend its use by the agricultural community. They consider that thorough experiments with this fertilizer should be made at the Central Farm, Coimbatore, and they approve of Sir F. Nicholson's proposal that prizes should be offered on the prize-field system for crops raised with the aid of this manure. The Board of Revenue is accordingly requested to offer its remarks on the best methods of giving effect to this and the other suggestions contained in paragraph 9 of Sir F. Nicholson's letter.

3. The Government also approve of Sir F. Nicholson's proposal to make experiments at or near Tellicherry in curing sardine, mackerel and other classes of fish by means of the processes specified in paragraph 10 of the letter.

* * *

Letter—from Sir F. A. NICHOLSON, K.C.I.E., I.C.S., Honorary Director, Madras Fisheries.
Dated—the 12th August 1908.

In modification of paragraph 9 of my letter No. 100, dated 13th July, on the subject of a cannery station near Tellicherry, I now offer to Government the suggestion to start a small fish-oil and fertilizer factory at the same place.

2. My reasons are as follow :—

(1) To popularize the idea and the methods of preparing oil and fertilizer it is, I find, not enough to await developments by European firms ; their methods and processes will be kept very secret, as is natural, and will therefore not serve as object lessons to people who require to have the matter forced into their notice. The possibility of profits on unfamiliar stuff of little local use, prepared in a corner by unknown processes, and marketed in distant countries by business methods requiring considerable organization, knowledge and enterprise, does not strongly appeal to a public of very small capitalists especially when the methods are conducted on a scale and at a cost generally beyond their means. Hence I propose to prepare and display a simple and public object lesson at all events as regards the industrial part of the problem ; I do not propose to enter the trade except in the necessary disposal of produce turned out, and then, if possible, only by selling to local brokers or firms. I rely upon the Agricultural Department to create a rural demand for the stuff, which—as whole fish—I now hear is largely used by Bombay ryots for tobacco ; since above 20,000 acres of tobacco are annually grown in the Coimbatore district, in which (letter above mentioned) I have already suggested the pushing of fish fertilizer as a manure, that district ought to provide a good local market.

(2) In working a cannery there will be a lot of stuff—stale fish unfit for canning, offal, etc.,—which will otherwise have to be thrown away ; this and fish bought locally from the fishermen who now dry the surplus catches for the manure brokers, will provide material for a small fertilizer factory.

(3) The business connection and boat arrangements which provide the cannery will help to provide the fertilizer factory.

(4) Apprentices learning one business can learn the other in the same place.

(5) The opportunity offers of showing that the business may be carried on with (*a*) small and (*b*) medium plant requiring (*a*) a few hundred rupees, (*b*) five or six thousand rupees as capital. This is what the coast people do not understand.

3. I propose an expenditure not exceeding Rs. 7,500 in setting up (*a*) a petty plant suitable for a simple fisherman or curer or syndicate of the same; (*b*) a medium plant suitable for a small capitalist or group of capitalists.

4. For (*a*) I shall simply provide (1) two or three open pan furnaces, (2) a small manual press, (3) a few vats, tubs and barrels with mat shedding and drying ground; in (1) the fish will be cooked, in the vats the oil and water will drain off, in (2) they will be squeezed for further oil; the barrels are needed for the export of oil. Rupees 1,000 should be ample for these needs.

For (*b*) I shall provide (1) a steam boiler of 4 h.p. nominal, and probably a suitable engine, (2) 3 or 4 open wooden vats for cooking by steam coils, (3) a larger press than for (*a*), driven by power if I have an engine; (4) a variety of draining and settling tanks, barrels, etc.; (5) a few small iron-roofed sheds and drying ground. The steam boiler with injector, all steam connections, etc., costs in Madras, at the Public Works Workshops, below Rs. 1,000; with engine below Rs. 1,800; the press may cost nearly the same; the steam cookers Rs. 150 each; and so forth. I calculate Rs. 6,000 to Rs. 6,500 as a probable figure.

5. For the above sum, *plus* running cost, I can open a useful factory; if it is, for any reason, a failure, Government may lose somewhat in selling the plant; if it succeeds, Government can sell, if they wish, at full value and will have established a valuable industry without cost. As a matter of fact I know that certain small capitalists are waiting for a lead exactly in this way and matter.

6. Of course if Government wish, I am prepared to put in proposals and estimates for about half a lakh as I have full data for such plant; this would be a full sized concern, and I do not recommend starting in this fashion: moreover it would be simply competing with existing

large firms and not benefiting the small folk, whereas my object is to introduce plant and methods suitable to a hundred small folk and firms along the whole course of the coast, so that the fresh catches may be dealt with on the spot as and where they arrive.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., I.C.S., Honorary Director, Madras Fisheries.
Dated—Madras, the 18th October 1909.

REGARDING THE ESTABLISHMENT OF AN EXPERIMENTAL STATION AT CANNANORE.

* * * *

4. In accordance with the statements in paragraph 15, etc., of my letter read in G.O. No. 2267, Revenue, dated 17th August 1908, and in other places, I purchased, when in England, from the London firm therein mentioned, a can-making plant somewhat better than that noted in the paragraph, but nevertheless costing net, i.e., deducting the trade discount which I obtained, only £83, f.o.b. London, to which must be added freight to India, so that the gross cost will be about £100 or Rs. 1,500 as expected. The plant is quite sufficient for small operations and can be enlarged at any time, and as it is from the same firm which supplied a Coimbatore Company for tinning coffee I hope to get my men trained there. The Company has very courteously acceded to my request to train men, and suggests that if this is insufficient they will be pleased to send me their expert Manager for a week or so in order to give more complete instruction ; a fee and expenses will of course have to be paid to such Manager. I anticipate no difficulty in getting my men thoroughly taught.

5. I have also obtained rudimentary plant for canning operations, viz., steam retort and steam vat from an absolutely first-class firm ; the boiler to supply steam I expect to get through the Madras Public Works Stores or, failing them, in Bombay. I obtained a trade discount of 20 per cent. on the goods ordered, the retort costing £48 instead of £60 and the vat £10 instead of £12. I have also ordered a small steam autoclave or

kettle, self-contained, *i.e.*, producing its own steam by heat applied direct, and capable of high pressure ; this is for experimental canning when it is, of course, undesirable to use the large plant ; the autoclave will cost about £25 delivered and will hold enough cans for practical experiment on a considerable scale, e.g., 30 or 40 one-pound cans. Nothing further is needed for first operations in canning except such material as can be locally obtained, viz., fittings, sheds, tin plate, cases, etc.

6. For operations in smoking, pickling and other methods I rely, as usual, on simple plant all procurable locally and need not give details. But I have bought one or two items of plant for peripatetic work such as a portable iron smoking kiln, etc. I intend to begin seriously on an attempt to utilize the abundant sardine as good and cheap food in the ways indicated in my letter read in G.O. No. 2267, Revenue, of 1908, e.g., by pickling (like pilchards and herring), by drying and smoking, and by canning in bulk ; all other fish will be similarly dealt with. The method of potting will be very specially attempted, and that of mealing fish, while my initial attempts at preserving fish fresh (by absolutely innocuous methods) for 24 hours and more, will be pushed further.

7. In accordance with the general sanction conveyed in your D.O. 1180-B/08-1, I have arranged to open a very small oil and fish guano plant in order to utilize fish which cannot, for various reasons, be turned into whole some food ; I have bought a small oil press (Rs. 450) suitable for expressing oil from boiled sardine and propose to purchase the remaining small plant locally, viz., open boilers, settling tanks, pumps, tubs, etc. I also bought a portable open-pan boiler self-contained (with stove, etc.) for touring work. This will be a plant on the very smallest scale and will not cost Rs. 1,000 ; with a cheaper press such as may be made locally, and mere iron pan boilers over brick furnaces, it will cost local fishermen much less, and I hope to influence quite a number to take up the business of boiling the fresh or dried sardine, expressing the oil, and selling it and the guano to local merchants. One enterprising man at Cannanore, about whom I wrote last year as an enquirer, is now doing this, and selling his stuff at a fair price, and I hope to get many others to do the same ; I can also

show them better methods and better implements which will save them from groping in the dark and will prevent waste of time and disappointment. I shall probably ask Government for a small further development shortly.

8. I am negotiating at Ratnagiri to hire one or two of the well-known Ratnagiri sailing boats in order to begin deep-sea operations under my own control; they will ordinarily bring me daily supplies of fish but I shall be able to insist on the gutting and cleaning of all dead fish on board *as soon as caught*, and the keeping in live chests of certain classes of fish taken alive, so that on coming ashore dead fish will not only be as free as possible from taint but will be actually ready for the curing tub, etc., while the live fish will be available for any process. My great trouble at Ennore, apart from the paucity of fish, has been that the fish have been caught an indefinite time, not less than 2 but perhaps as long as 6 or 7 hours; hence experiments were vitiated because some fish were fairly good and some in the early stages of taint by the time I could deal with them; this will be avoided by the arrangements now beginning at Cannanore. Moreover, in January and February these Ratnagiri boats are accustomed to fish in the deep sea for shark, etc., and stay out a week at a time; I intend to utilize this habit to introduce the new Salt rules for taking duty-free salt to sea. At present these boats (which seldom come so far south as Cannanore) take out duty-paid salt which, being expensive, is taken and used in very scanty quantity; hence the catch by the end of the week is apt to be putrid, and it is evidently these to which Mr. H. S. Thomas alluded when he stated that the catches usually come ashore putrid and full of maggots. Under my control these boats will take out plenty of salt and salt down their catches properly, so that not only will the product require little handling when it arrives on shore but it will be untainted.

9. In establishing new or developing old industries each advance usually means the collateral advance of some connected industry. The present is no exception, but I will not further deal with this point save to say that successful canning will necessitate an improved vegetable oil industry, and successful curing, especially pickling, means a large wooden barrel and box industry.

As regards edible oils I may have to address Government shortly, as they must be both cheap and above suspicion, and I do not at present know of any plant in this Presidency for refining crude vegetable edible oil in such way and with such thoroughness that I could use it in canning.

10. If these operations are successful Government will have introduced notable industries of great value yet workable by small folk in scores of localities all along the West Coast, and on their establishment Government will be able at once to sell its plant practically without loss, as I know by enquiries already made. But in any case the experiments are well worth the few hundreds of pounds which they will, at most, cost.

ORDER—NO. 3488, REVENUE, DATED 18TH DECEMBER 1909.

The proposals of the Honorary Director of Fisheries regarding the establishment of an experimental fishery station at Cannanore and the operations proposed to be conducted by him on the West Coast are approved.

Letter—from R. A. Graham, Esq., I.C.S., Collector of South Canara.
To—the Secretary to the Commissioners of Land Revenue.
Dated—the 7th April 1911.

I have the honour to forward a copy of a letter I have received from the Honorary Director of Fisheries on the subject of the grant of suitable pieces of Government land to persons desirous of engaging in the manufacture of fish oil and fish manure in accordance with the system he is trying to introduce. From a conversation I have had with Sir Frederick's Assistant, I gather that the chief difficulty in the way of such persons lies in the darkhast rules. There seems to be a future before the scheme if it can get a fair trial on this coast. There is a very large demand for fish manure and constant complaints that the fish manure now obtainable contains an excessive admixture of sand; so that any process by which it can be supplied free from sand ought to develop a considerable trade. The land required for the factories will always be near the sea-shore, and in some cases it may be possible to lease convenient plots to the manufacturers without permanent assignment; but even this may be contrary to the spirit of the darkhast rules and, where the question of assignment arises, the preferences allowed by the rules will frequently prevent the applicants from getting the land they want. I beg, therefore, that the Board will obtain the sanction of Government for the relaxation of the rules in such cases.

Enclosure.

Letter—from Sir F. A. Nicholson, K.C.I.E., I.C.S., Honorary Director of Fisheries to the Government of Madras.
To—the Collector of South Canara.
Dated—Chepauk, the 29th March 1911.

You are aware of the large quantities of oil sardine caught on this coast which, after being sun-dried on the sandy beach, are exported mostly to Ceylon and other foreign ports and a comparatively small quantity sent to the planters in South India. This process of manufacturing fish manure is very primitive; the oil which is in itself a very valuable commodity is not only wholly wasted but, in drying, takes up with it a large quantity of sand (30 per cent. or more) which by no known methods can be got rid of after it once adheres to the fish. Neither sand nor oil are required by the planters, nevertheless they have to pay for them and incur all the incidental charges for transport to their estates hundreds of miles from the coast. Moreover, this primitive process is objectionable from a sanitary point of

view, but apparently it has been tolerated hitherto, in the absence of other improved methods, owing to the large demand for fish manure of any sort as a valuable plant food.

My department have, by a series of experiments conducted during the last few years, found out the best method of manufacturing the manure and extracting the oil from sardine. It consists in boiling the fresh fish in open boilers made of iron or copper, and pressing the residue under screw presses worked by hand. The oil is separated from the dirty water which is thrown away, and the pressed cake when dried and milled gives a high class of fish guano which is free from all bad smell. The process itself is practically free from smell and from any sanitary objection.

This new process has been adopted by some private parties and several factories have already been opened on the coast. My department have, by advice and practical demonstrations held at important fishing centres, been encouraging many others to start such factories. As the selection of a proper site adjoining the beach is a very important factor for the successful working of these factories, I have the honour to request that you will be pleased to grant, on favourable terms, unoccupied Government land suitable for this purpose to applicants who wish to open such factories in your district. Before the land is granted I would request you to forward to me the applications for scrutiny so as to enable me to ascertain whether the applicants will adopt the correct methods of manufacture and whether they have the capacity to carry on the business on proper lines. This, I think, will be of assistance to the Revenue Department in granting sites.

REFERENCE, DATED 21ST APRIL 1911.

Submitted to Government.

2. The Board recommends that the Collectors of South Canara and Malabar may be authorised to grant, in consultation with the Honorary Director of Fisheries, leases of land on the coast, subject to the conditions laid down in G.O. No. 3904, Revenue, dated 9th December 1910.

GRANTS OF LAND FOR FISH-OIL AND GUANO FACTORIES.

ORDER—No. 1593, REVENUE, DATED 29TH MAY 1911.

The Government consider that the power to grant long leases of lands on the sea-shore for the erection of factories should not for the present be delegated to Collectors, but the Collectors of Malabar and South Canara and the Honorary Director of Fisheries may be informed that the Government are prepared to give favourable consideration to proposals to grant such leases to persons desirous of engaging in the manufacture of fish oil and fish manure.

ORDER—No. 3038, REVENUE, DATED 8TH NOVEMBER 1909.

The Honorary Director of Fisheries is informed that the Secretary of State has sanctioned the creation of the appointment of a whole-time officer as Marine Assistant in the Fishery Department for three years and the appointment of Mr. J. Hornell, F.L.S., to the post * from 3rd July 1909 on a salary of Rs. 700—50—900 per mensem with the travelling and leave allowances admissible under the Civil Service Regulations to officers of corresponding rank. A copy of the agreement executed by Mr. Hornell is forwarded to the Honorary Director, who is requested to report with reference to clause 8 in which vernacular language Mr. Hornell should be required to pass.

2. A report should be submitted to Government in two years' time whether the permanent retention of the appointment is required.

In compliance with paragraph 2 of the above order, a report was made in 1911 requesting Mr. Hornell's retention, which was accordingly sanctioned in G.O. No. 201, Revenue, dated 24th January 1912. In 1915 Mr. Hornell's appointment was made permanent and pensionable.

Early in 1909 proposals were made to Government that Mr. Hornell who had had much tropical experience in Ceylon as Marine Biologist and Superintendent of Pearl Fisheries, should be made Superintendent of Pearl and Chank Fisheries for the Madras Presidency; this was sanctioned in G.O. No. 601, Revenue, dated 4th March 1909, since which time Mr. Hornell has combined these duties with those of Marine Assistant.

Hence by the appointment of Mr. H. C. Wilson as Piscicultural Expert in November 1907, and of Mr. James Hornell, F.L.S., in 1908, the Department obtained the expert and valuable services of two practical European scientists in the several branches of pisciculture and fishery developments.

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* [Mr. Hornell had already been appointed temporarily for one year from July 1908, with the result that his further retention was suggested during the course of the year.]

Letter—from Sir F. A. Nicholson, K.C.I.E., I.C.S., Honorary Director of Fisheries.
Dated—the 1st July 1910.

I have the honour to submit herewith two papers by the Marine Assistant, Mr. James Hornell, on the subject of edible oyster culture, viz. (1) a report, with general suggestions for India, on oyster culture as practised at Arcachon, France, and (2) a note containing specific suggestions for beginning work on Arcachon lines, at Pulicat. These papers embody the suggestions, by an expert, foreshadowed in the first sentence of paragraph 169 of my report on fisheries in Japan, and relating to developments of oyster culture in this country; see also paragraphs 42 and 65 of my No. 55 of 1908 read in G.O. No. 1635, dated 12th June 1908.

2. As mentioned in my Dis. No. 68, dated 11th February 1909 (disposed of in G.O. Mis. No. 525, Revenue, dated 24th February 1909), I intended, when recently on leave to Europe, to utilize my own and Mr. Hornell's time in inspecting, *inter alia*, the Arcachon methods of which we both had a general but not detailed knowledge; personally I was unable to go there, but Mr. Hornell carried out the plan, and the accompanying report is the result. I think that Government will agree with me that it is a very valuable and practical bit of work, and may be the basis of large developments in this country.

3. Apart from the mass of practical details which, with other knowledge gathered by Mr. Hornell, will enable us at once to set on foot the experimental culture of the oyster with every prospect of commercial success, the great lessons for us in this report are (1) that by the careless and selfish depletion of oyster beds carried out by purely private interests and unrestricted by public regulation, the richest oyster beds may speedily be ruined; (2) that wise regulation will prevent such depletion; (3) that where depletion has occurred, wise regulation coupled with scientific industrial assistance may not only restore a decadent or decayed industry but may develop it far beyond its former scope. The Arcachon oyster beds which, in the middle of the 18th century, were maintained in fair productivity by Parliamentary regulations necessitated by the heavy drain upon their resources, fell into complete ruin by the middle

of the 19th century owing to the unrestricted ravages consequent upon an unlimited demand and the disuse of the earlier regulation; the genius of Coste and other scientific and practical experimenters who were supported or fostered by the resources of the State, found the remedy in systematic oyster culture, with the result that the Arcachon beds which in 1859 furnished only 700,000 oysters valued at 28,000 francs, supplied in 1907 no less than 352½ millions valued at 2,659,460 francs, a value much below the real value since many millions are sold immature—at two years of age—for being fattened elsewhere. Besides this large output of native oysters nearly 96 million Portuguese oysters were also grown and sold. About 1,000 million oysters are under culture at any one time on the 7,500 odd acres which are held in about 3,000 holdings, the small holding being the one especially fostered by Government as a provision for its naval reserve. The figures of output of native oysters show an annual outturn per acre of about 45,000 or slightly over one per square foot; there must be present an average of about three oysters per foot or 135,000 per acre, since the gross number any one time under cultivation is 1,000 million. Hence it will be seen that a great source of wealth and industry was ruined by carelessness and absence of regulation, but more than restored by authority, science and industry working in combination; State regulation and State assistance in experiment have re-created Arcachon.

4. One immediate result of Mr. Hornell's enquiry is the second paper for which we had laid the foundation by the examination of the Pulicat Lake by Mr. Hornell in 1908, as reported in the first paper in Departmental Bulletin No. 4, and by the preliminary experiments in oyster culture at Ennore recorded, for 1908, in the second paper in the same bulletin, some remarkable results of which are mentioned in paragraph 17 of my annual report for 1908-09 read in G.O. No. 1215, Revenue, dated 4th May 1909. These Ennore experiments were repeated on the same ground in the autumn of 1909 with still more remarkable results; briefly, it may be here stated that on tile collectors deposited in the backwater between 19th September and 12th October, very many young oysters were found on the 19th November, the sizes of which varied from very small to

as much as $1\frac{3}{4}$ inches in diameter. Since the oysters could not possibly be above two months old, this rate of growth is very remarkable, and exactly corresponds with similar results in 1908 when the largest oysters of not more than 11 weeks old, and possibly less, reached a diameter of $1\frac{3}{4}$ and even $1\frac{7}{8}$ inches. Subsequent examination on the 26th March last (1910) showed that while, owing to over-crowding on the tiles, the general mass of young oysters had not much increased in size, those, on the outer edges which had more room and more food, had greatly developed showing sizes up to 3×2 inches, $2\frac{1}{2} \times 2$, etc., on the tiles laid down on 19th September 1909, and up to $3 \times 2\frac{1}{2}$ on tiles laid down on 12th October 1909; the sizes slightly decreased on the tiles laid down later than the 12th October, but nevertheless were as much as $2\frac{3}{4} \times 2\frac{1}{2}$, $2\frac{1}{4} \times 1\frac{3}{4}$, etc. Hence it is proved that in slightly over five months oysters can be deposited as spat and grow to the size of $3 \times 2\frac{1}{2}$ inches, a rate of growth unparalleled or unsurpassed anywhere. Not only so but the oysters deposited on our tiles in October 1908 showed on 26th March 1910, or within eighteen months, a growth in inches as follows: $4\frac{1}{4} \times 2\frac{3}{4}$, $4\frac{1}{4} \times 2\frac{1}{4}$, $4\frac{1}{8} \times 3\frac{1}{4}$, $3\frac{1}{2} \times 3$, $3 \times 2\frac{1}{2}$, $3\frac{1}{4} \times 2\frac{1}{4}$, etc. These oysters were healthy and fat, while the shells were well developed being from $1\frac{1}{4}$ to $1\frac{1}{2}$ inches in thickness, while the flavour was, Mr. Hornell says, the finest of any he had eaten in India; these oysters, he adds, were of just the proper size for use.

Hence it has been already proved to demonstration that we can raise oysters of good size and excellent quality, fit for table consumption, within 18 months from spat fall. It may also be mentioned that the spat fall again occurred immediately after the fresh water floods in the backwater, and was earlier in 1909 as were also the floods.

5. With the sanction, therefore, of Government I now propose to develop our preliminary Ennore experiments into a small but systematically arranged experiment in oyster culture, in view to its eventual public acceptance as a regular fishing industry of simple and readily learned character, easy control, and great value, which private individuals, however unlearned and poor, can carry out with ease and profit. The oyster industry has the advantages that its subjects are stationary, its locale is

in shallow, safe waters, and its returns calculable, while the fresh products will be in considerable local demand at high prices, and any surplus can either be sent to Calcutta, etc., in ice after being shelled as in America, or converted into goods (in cans, extracts, etc.) in general demand.

6. Mr. Hornell considers, and I concur, that the East Coast of this Presidency is better suited than the West Coast for oyster culture, since, except where there is very free communication with the sea, as at Cochin, the West Coast backwaters are, for several months, so diluted with floods of fresh water that no oyster could live in them ; these conditions do not obtain in our East Coast backwaters. Moreover oysters are only found in patches in the West Coast estuaries, and hardly at all in the open sea, whereas the margins of the East Coast are frequently fertile in oysters attached to the mangroves and rocks. As at present advised, we consider the Pulicat Lake or backwater to be the most suitable place for beginning operations ; the backwater is convenient both in position and character, its bar is generally open to the sea, and very good oysters are found there, though only in patches ; these can be utilised as breeders (1) by fencing in about three acres—in two plots—of the lake as culture beds (parks) and preparing them for cultural operations, (2) by carrying out in these plots the cultural operations found desirable, these being based in the first instance on Arcachon methods, (3) by the issue of Government Orders prohibiting the taking of oysters from the scanty existing beds within the lake.

7. The work will of course be experimental at first since no such cultural attempt has ever been made in India, and we shall have to ascertain not merely the best form of spat collectors but the exact season or seasons in which to put them in position, the enemies and dangers to which the oysters will be exposed, the best localities for further work, the ages at which, and the methods by which, oysters will give the best commercial return, and the best means for the disposal of our crops ; two or three years should enable us to answer the above questions.

8. Mr. Hornell has given in the second of his papers full details of the experiments proposed and of their cost which, annually, will be very small ; the capital cost of

fencing and preparing the two acres which will be first dealt with, will not exceed Rs. 2,800 of which only half will be required in the current official year; the recurring cost may be about Rs. 1,200 annually of which Rs. 600 will be required this year; hence, in round figures, Rs. 2,000 will be needed this year, and Rs. 2,000 next year by the end of which period there should be a considerable crop of marketable oysters and, above all, a new industry in actual, though infant, operation.

The essence of the experiments is simply this; small areas of the lake bed, about two acres in one area, and one in another, close to existing oyster beds, will be bunded in by bunds of perhaps a foot high, merely intended to retain water at very low tides and ordinarily submerged entirely; these areas (parks) will be specially prepared by cultching, etc., for the due receipt of young oysters which will be obtained by placing tile collectors in the selected areas on which the spat from the adjacent oyster beds will fall, and by subsequently removing the young oysters from the tiles and putting them out for growth in the selected breeding parks. Probably the process will be assisted by transferring natural oysters from the beds to the parks, but the above is the proposed system in outline. As already mentioned, experiments have shown us that good marketable oysters can be obtained in eighteen months after the spat fall, so that by March 1912 we may have on the first acre a lakh of good oysters and on the second acre a large number of young ones; in four years' time there should be on three acres several lakhs of oysters in various stages from infant to marketable.

9. The third point adverted to at the close of paragraph 6 *supra* is however essential, viz., the issue of orders by Government wholly prohibiting, for the present, the taking of oysters from the lake except by the Fisheries staff or persons authorized by the department. There are few and small beds, and no oyster taking industry at present exists at Pulicat. But recent advertisements by a firm which was—apparently temporarily—located at Pulicat, stated that dried or other oysters would be supplied on demand, and it is obvious that any one who could find a market for dried or preserved oysters might destroy the whole existing beds in a single season, and consequently the whole of the brood oysters

on which the lake, and our cultural experiments, depend for spat ; destruction of the beds would mean great additional expense and very great additional difficulty in re-stocking the lake. There can be no doubt but that the bed of the lake is Government property and the High Court have decided (I.L.R., Vol. XXVII, July 1904, Madras, Annakumaru Pillai v. Muttupayal and others) that "chanks are not fish. They are not *feræ naturæ* but are *domitæ naturæ*, and must be placed *in the same category as oysters so as to be the subject of theft.*" Moreover, as Mr. Hornell points out, the Bombay Government exercise complete ownership and jurisdiction over the oyster beds in the Sind backwaters, etc., and the Kutch Darbar over the beds within their territory. Hence Government may declare that the oyster beds in the Pulicat Lake are reserved land and that their products are removable or in any way to be dealt with only by officers of Government, and that persons interfering with these will be liable to the penalties for theft, or mischief, etc. The whole of the lake, however, need not be brought under the order but only such very small part of it as will affect our operations, viz., the area enclosed by a line drawn east and west just north of Annamalaicheri (see plan in the first paper in Bulletin No. 4) and another line at the entrance of the canal into the lake at Vadamanikuppam (see plan accompanying Mr. Hornell's letter of the 18th instant). If Government approve, a proper proclamation with all boundaries, etc., will be drawn up and submitted to Government.

10. As work should begin on the spot by about 1st August next the very early orders of Government are requested, first for sanction, should they approve, for the carrying out of the experiment and for the outlay of the necessary funds, (2) for the handing over of the areas which we require and which are indicated on the plan attached ; as the Buckingham Canal is under the control of the Public Works Department, the transfer of the necessary sites may be ordered in consultation with that department. The plan will show that the sites required in no way affect the canal, and as a matter of fact, our operations will be so slight and of such a simple and unobstructive character, that the canal could not possibly be affected. The bunds raised for the protection of the oysters are but a few inches above the level of the lake

bed and are merely intended to retain water when the surrounding lake bed is occasionally uncovered by very low tides.

ORDER—NO. 2442, REVENUE, DATED 23RD JULY 1910.

The Government agree with the Honorary Director of Fisheries that Mr. Hornell's report on "the practice of oyster culture at Arcachon and its lessons for India" is a very valuable and practical piece of work.

2. The Honorary Director's proposals for the conduct of experiments in oyster culture in the Pulicat Lake are approved.*

* This farm was started shortly after the date of the Government Order. Droughts and fresh water floods have caused unforeseen difficulties while expert superintendence was almost impossible. Nevertheless excellent oysters are now being produced and marketed with success, and with the educated superintendence now available, the farm should rapidly progress.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., I.C.S., Honorary Director, Madras Fisheries.
Dated—the 19th July 1911.

I have the honour to submit herewith copies of Mr. James Hornell's note on "Marine Fish-farming for India," being a report written by him on his inspection of the fish-farming at Arcachon and Comacchio in 1909, together with general suggestions for work in Madras.

2. The report is the outcome of the department's frequently expressed desire to see the numerous Madras backwaters properly utilised ; I had specially intended in 1909 (see my letter Dis. No. 68, dated 11th February 1909, read in G.O. Mis. No. 525, dated 24th February 1909), to visit the above places, but my inability to do so was fortunate since it threw the whole duty on Mr. Hornell, who, possessing both practical and scientific knowledge, has been able to concentrate attention on the necessary details and consequently to write a very useful report on which we may begin fish-farming work with the minimum chance of mistakes.

3. The word "fish-farming" has been used to distinguish the method from the marine pisciculture or, rather, hatchery work of which we generally hear. In America and elsewhere marine pisciculture is mainly confined to the artificial hatching of thousands of millions of the eggs of food fishes and the release of the fry into the waters of the sea to shift for themselves. But the fish-farming here reported on is simply the retention of fish in enclosed ponds or lagoon enclosures into which the young fry, hatched in the open waters of the sea, are enticed, or in which they are born as the progeny of mature fish already within the enclosures ; in these enclosed areas they live and are brought to maturity on the food naturally contained in the water which is constantly changed by aid of tidal ebb and flow and by the drainage waters from the surrounding country, and thence are removed for market.

4. As Mr. Hornell points out, the process is very inexpensive and simple ; primitive in fact in all except the ingenuity, born of long experience, with which the waters are dealt with, in view to maintain normal wholesomeness, temperature, salinity, and a supply of natural food, and by which the fish are enticed into the enclosures, maintained against extremes of cold, and eventually

captured for market. Mr. Hornell lays stress on the fact that no attempt is made at the alternative method of fish-farming, viz., that of the intensive culture, by artificial hatching and artificial feeding, of sea fish as practised in Japan and probably in Japan only (see paragraphs 179 to 184 of my " Note on Japanese Fisheries ") and that, in all probability, the artificial hatching—so easy in these days—of millions of fry and their nourishment by adding artificial food to the natural contents of the water, would immensely aid their productivity and profits.

5. In fact, the actual produce per acre of the fish-farms reported on is disappointing as compared with potential produce ; that for Comacchio, the origin of which goes back to Roman times and in its present form is many centuries old, is decidedly poor, though evidently much larger three hundred years ago when the money value of its output was higher than at present though money was several times its present value. At Arcachon, however, the average output is better, and averages 264 lb. per acre, valued at Rs. 65, a very fair outturn for water to which no artificial aid is given to increase the produce, and about double the ordinary outturn of carp per acre in German lakes, except in Bavaria. But it is to be noted that this outturn—at Arcachon especially—is obtained with very little labour and expense ; a fish farmer with 100 hectares, or 243 acres, clears £1,000 profit *per annum*, and for this large area he employs only *four* labourers, while the cost of repairs is but small. When compared with the produce of an equal area of land, requiring to be ploughed, sown, cultivated, manured, harvested, at large expenditure of labour and money, and with, after all, very uncertain results owing to variable or adverse seasons, the outturn is decidedly good and recalls an expression actually used to myself in Bavaria by a successful arable and carp farmer whose farm was half land, half water, that he wished that the whole of his farm were water.

6. The areas under fish-farming in Arcachon and Comacchio are the low-lying lands on the sea margin which in nature form marshes and lagoons, periodically overflowed by the sea, or, when separated from the sea by low spits of land, are subject to the periodical in and outflow of the tides through a bar : these have often

been artificially embanked and sluiced in order to form solar salt-pens ; at Arcachon the farm sites are, in fact, chiefly old salt pans, while at Comacchio the land has, from time immemorial, been gradually dyked and sluiced till it is a maze of ponds and canals ; the fish farm area of Comacchio is about 90,000 acres, while that at Arcachon is only about 740 acres.

7. Now these classes of water are precisely paralleled to an enormous extent in this Presidency ; on both coasts there are numerous and very large backwaters, such as Pulicat lake of 180 square miles, Covelong, Dugarazapattanam, etc., while the west coast is largely a chain of backwaters. Besides these there are deltaic marshes and even disused salt pans. Numerous areas are capable of being reclaimed, such as the small arms or reaches of the west coast backwaters, and marshy areas which need little but embanking and sluicing to form first-class fish-farms. The questions then arise (*a*) whether the creation of marine fish-farming as an industry is worth while ; (*b*) if worth while, whether it is possible ; if so (*c*) what are the most suitable fish, and (*d*) what methods should be adopted.

8. Positive and assured answers cannot at present be given to any of these questions for the simple reason that no such thing as marine fish-farming has ever been attempted or even its possibility examined in this Presidency. It is precisely one of the problems for the solution of which *by experiment*, "Fisheries" exist and, as will presently be shown, the problem is eminently worth a few years of experiment. For the problem is to render *fully productive* by cultivation huge areas of water which at present are only semi-productive ; just as wild lands produce a certain small amount which may be enormously increased by proper farming, so these waters if duly farmed should produce much greater yields than at present. For instance, though Pulicat has oyster beds and a good spat fall, and there is little or no removal of the oysters, there is but a small wild crop of oysters, whereas in the culture experiment now in process there, a small two-acre enclosure is expected to yield, as a first and experimental crop, some 15,000 dozen mature oysters in 18 months from beginning the experiment. The example is perhaps not quite parallel, but it *is* an example of culture *v.* nature.

Then again, if these areas can be made fully productive an enormous amount of food can be easily grown and easily harvested by men of any class. For such harvesting no dangerous work and exposure, as in deep sea fishing, are necessary, and both cultivation and harvest can proceed in all weathers and seasons, while men of the ordinary Sembadavan class can engage readily in such work. If, for instance, only 16,000 acres out of 116,000 of Pulicat lake alone were under fish-farming, and produced only at the Arcachon rate of $2\frac{1}{2}$ cwt. per acre, 2,000 tons would be annually produced by this fraction of the lake, and there are many areas better suited for farming than Pulicat, though not so extensive, *e.g.*, Dugarazapattanam, and probably Covelong ; this would be almost an assured annual harvest, obtained with the minimum of trouble and risk.

This rate of produce, however, may be largely increased by culture and additional food, especially considering the rapid growth in tropical waters, particularly when food, naturally considerable, is artificially increased and where precautions are taken to prevent either cannibalism by the fish under cultivation, or the attacks of predaceous foes. There is no reason to suppose that marine fish, confined in conditions *suitable to their nature*, will grow less rapidly than fresh-water fish, and the recorded accounts of their growth, as mentioned in paragraphs 196 to 198 of my "Note on Japanese Fisheries" are astonishing and suggestive. With these figures may be compared the phenomenal rate of growth of the edible oyster as ascertained by our Ennore and Pulicat experiments of the last three seasons, viz., full maturity and fitness for market in 18 months from spat fall. Hence a few acres of properly farmed and protected backwater should provide a good income even though fish be priced at but one anna per pound. Since these areas are mostly owned by the State it will eventually be possible to draw from them a revenue which will maintain the department without recourse to the general purse. Hence there is every reason for taking up marine fish-farming as a most important Government experiment, in order to ascertain its methods and its possibilities, and to provide examples for imitation.

9. That fish-farming, if possible, is worth while, has been argued. That it is *possible* is practically certain ; if

possible in Arcachon and other parts of France, as well as Italy, it is possible in the still more favourable conditions of this presidency. Provided that the general water-way is unobstructed there are tens of thousands of acres of perennial water, unencumbered by vested rights or interests which can be turned into productive fish-farms at slight expense; slight, that is, as compared with probable results and with subsequent annual expenditure. The property in these waters is mostly vested in Government who can assign areas, on lease or otherwise for cultivation as properly as areas of arable land, and should the expected success attend our experiments, it will be a subsequent duty to ascertain conveniently placed areas suitable for private farming. Considerable fishery produce is already obtained especially in several of the backwaters such as Chilka lake, Pulicat, Cochin, etc., these fisheries, however, are simply in a state of nature, and were the system of taking in common the mere natural produce of these waters to give place to enclosure and cultivation, there can be no doubt but that the produce would increase as vastly as the produce obtained by the enclosure of arable commons. In pages 77 to 83 of his report Mr. Hornell shows, in fact, that several of the main conditions of successful fish-farming are more favourable in this Presidency than in Europe, such as the much larger variety of prime fish suitable for growth in enclosures (see paragraph 10 *infra*), the warmth of the waters leading to abundance of minute life and consequently to rapid growth of the fish, the absence of a rigorous winter when growth is at a stand-still, and so on. Having, then, the water, the fish and the favourable conditions, it is obvious that the application of intelligent experiment should—I might almost say must—result in success.

10. Assuming that fish-farming is both important and possible, it remains to consider *what fish are most* suitable. Here Mr. Hornell's practical and scientific knowledge are already of the first importance; his remarks are contained in pages 63 to 77 of his report. Knowledge of the fish found suitable in European waters for growth in quasi-confinement gives a starting point for our own investigations. Those fish are eel, mullet, smelts and bass, and a sprinkling of other fish; those named are the chief ones, especially the three first

mentioned, of which the eel is by far the most important. In Japan eel and mullet in the brackish waters of the Tokyo ponds were found to be the fish chiefly cultivated.

Now in this Presidency the eel, though found in some quantity, is not abundant or in general favour, and may at present be neglected. The mullet, of various species, is one of the most abundant in the backwaters forming a large item, for instance, in the Ennore catches. But Mr. Hornell points out that we have, *in addition*, quite a variety of much more valuable fish, habitually found in our backwaters, such as the koduva (Lates calcarifer, begti or cock-up). The kálá or bámín (Polynemus), sea-bream of several species, and even, when young the white pomfret according to Dr. Day ; also others of less food value.

The mullet is very suitable in many ways ; it is omnivorous and consequently easy to feed, while, as frequently caught at the Ennore station, it is at certain seasons, full of ripe spawn or milt so that the eggs could be artificially fertilized and hatched with great ease for farming purposes. Mr. Hornell estimates that these fish would be quite marketable in a year from entering the ponds as fry. Mr. Hornell also points out that since at least some species of the polynemids (bámín) enter the backwaters and tidal rivers for spawning, there should be no difficulty in obtaining ova for artificial hatching ; so also with Lates calcarifer and some other fish. Also that the fry of several valuable species are found in enormous quantities at various seasons in the backwaters and could be obtained with the utmost ease for rearing in enclosures ; they may be caught abundantly in ordinary push nets along the banks, since children catch them in quantity by using their cloths as nets. If the white pomfret is really susceptible of cultivation in enclosures as suggested by Mr. Hornell, a most valuable fish would be brought into comparatively common consumption.

The fish mentioned are not only valuable as food fish but have apparently accustomed themselves to those large and rapid variations in the water which we find in our backwaters and which would be fatal to European farming. Mr. Hornell mentions the matter of salinity in some detail and points out the wide extremes, so

observable in the backwaters. These variations need give little anxiety, since the fish are habituated to them.

11. We have, then, a much greater variety than in Europe of fishes suitable for cultural work, at least experimentally, and therefore very great chances of successful fish-farming. But Mr. Hornell also points out the regrettable fact that we know very little about our food (or other) fishes as regards (*a*) breeding habits, (*b*) food, (*c*) ability to live in comparative confinement, and that we require to experiment in the laboratory as well as in small fish farms, before we can definitely say which fish are the most suitable, both in their ability to thrive in enclosures in the conditions and on the food therein available or in the food which we can supply with sufficient cheapness, and in their food value. I beg to refer in this connection to my remarks in paragraphs 6 and 10 of my No. 163, dated 1st June last, on the necessity for giving "Fisheries" a domicile with a small biological laboratory and hatchery in the proposed new aquarium, and the practical advantages arising therefrom. As Mr. Hornell says (page 82) "Observations are urgently needed upon the breeding habits and the nature of the food of the principal backwater and estuarine fishes, and experiments in artificial impregnation and hatching are needed before marine fish culture can be carried on commercially with fair assurance of eventual success." So also in page 74, he alludes to the need for a small hatchery attached to an aquarium and the opportunities which it would give for practical work. Hence, though we know that several of the most important natural conditions are more favourable to fish-farming in this country than in Europe, e.g., large variety of suitable and valuable fish, abundance of fish food, rapidity of growth, absence of rigorous winter, etc., yet more data are required before fish-farming can be *commercially* assured.

12. Consequently we come to the methods suitable to this country. Mr. Hornell (pages 77 to 83) shows that there are vast areas suitable for both methods of fish-farming, viz. (1) the so-called "natural" method in vogue at Arcachon and Comacchio, to wit, the setting apart of large continuous areas of water and simply enticing the young fish from the sea into these areas, where they grow, without artificial food, till fit for

market, and (2) the intensive method, practised in Japan, where marine fish are artificially hatched or hatched in confinement and brought to maturity in vast quantity in comparatively small ponds with the aid of artificial food ; see paragraphs 179–184 of my "Note on Japanese Fisheries."

13. For the present it is premature to discuss in detail commercial methods, since fish-farming is non-existent and we have too few data. Personally I incline to the belief in the intensive method which is agreeable to the Indian tendency towards "*petite culture*," and is enormously productive on very small areas ; I should like to see vast areas of the shallower parts of our backwaters reclaimed and turned into small fish farms. Traversing these backwaters, especially in Travancore and Cochin, one may see hundreds of petty reclamations carefully embanked not to retain but to exclude water, and expensively unwatered, often by engine power, to enable land crops to be grown ; such areas would grow fish abundantly with the minimum of expense ; in any case, since ryots are willing to spend large sums in getting rid of water, they may be induced, if we can show them successful fish-farming, to spend smaller sums, in similar positions in keeping the water in. Natural food in these positions is usually abundant, consisting of small aquatic and semi-acquatic life, both animal and vegetable, while for the more expensive classes of fish such as the bámín and pomfret, it would be possible to supply artificial food in the shape of dry fish meal, etc., at extremely low rates.

14. For the present, however, the methods for mention in this letter are those to be adopted by "Fisheries" in experiment. These are (1) laboratory or aquarium methods, (2) pond farming as a working experiment in selected positions. The first has been mentioned and is essential if we are to gain an exact knowledge of the bionomics of food fish, and I trust that Government will sanction the proposal alluded to in paragraph 11 *supra*, viz., the provision of a small biological laboratory and hatchery attached to the proposed new aquarium. The second can be readily carried out in connection with certain salt-pans, the main supply channels of which are admirably suited for experimental work, being enclosed, protected from poaching and interference,

and properly sluiced; see pages 79 and 80 of the Report.

15. I trust, therefore, that Government will now expressly sanction experiments in marine fish-farming as part of the department's work, in which case Mr. Hornell will prepare and send in the necessary plans and estimates with all detail. As suggested in the first part of this letter, the experiments will be very cheap since, as regards laboratory experiments the small plant required is necessary and will be maintained for much other work, while as regards pond experiments we have the necessary sluiced waters all ready to hand, and it is believed that there are occasionally disused salt channels which could be placed entirely at our disposal.

16. Mr. Hornell's report is, I believe, the very first detailed English report made at first hand on these methods of fish-farming, except perhaps the mention of Comacchio in a report on the Adriatic sea fisheries by Faber, and I think that Government will agree with me that it is highly valuable and suggestive as the starting point for marine fish-farming in this Presidency and perhaps in India.

ORDER—NO. 2537, REVENUE, DATED 21ST AUGUST 1911.

The Government agree with the Honorary Director of Fisheries as to the value and suggestiveness of Mr. Hornell's report on "Marine Fish-farming for India" and will be glad to receive the detailed plans and estimates which Mr. Hornell proposes to prepare and submit.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., I.C.S., Honorary Director, Madras Fisheries.
Dated—the 20th April 1912.

Referring to G.O. No. 2537, Revenue, dated the 21st August 1911, desiring detailed plans and estimates for a marine fish farm as suggested by Mr. Hornell in his report on "Marine Fish Farming for India" (Fisheries Bulletin No. 6), I have the honour to submit copy of a letter from Mr. Hornell giving particulars and proposals.

2. After receipt of the above Government Order I requested Mr. Hornell to visit several parts of the coast in view to a general survey of fishery practices and possibilities and with the special object of selecting a convenient site. Mr. Hornell reports that many such sites are available, and in Ganjām a village officer has come forward to lease a lagoon area admirably suited for the purpose but too far from our general head-quarters to be departmentally worked. Finally Mr. Hornell pitched upon a site which though not perhaps ideal in all its conditions as a fish farm, is excellently situated for a first experiment which demands continual observation, experiment and control, viz., a lagoon area of perhaps 150 acres close to the chank godowns about a mile out of Tuticorin, perfectly unused, and communicating with the sea by a narrow inlet. His proposals to utilize this are mentioned in his letter and will be readily understood by the sketch. The Revenue and Marine authorities have stated in writing that they have no objection to the use of the area, and the Executive Engineer has prepared the estimate. Being close to the chank godowns the farm will be incessantly under supervision by the chank staff as well as by Mr. Hornell during his lengthy stay at Tuticorin in the pearl and chank season.

3. Since Mr. Hornell's letter was written he has suggested to me that the farm may be used not merely for food-fish farming but for the cultivation of (1) the window-pane oyster (*Placuna placenta*), (2) the ordinary oyster, in a position where it will be daily under observation in quiet and enclosed waters. The first named is not unimportant; the fish is not unknown in Madras waters and is also found largely in Ceylon; its former industrial use is well-known, and though such use had apparently died out it is now reviving where a subdued light is required, a notable instance being in the new and up-to-date

American hospital at Manila in the Philippines. In Ceylon this oyster is fished extensively as a source of seed pearls, which are a Government monopoly.

4. The total cost for the current year is Rs. 4,700, of which Rs. 4,410 will be capital non-recurrent cost, and Rs. 290 recurrent. The pay, Rs. 15, of each watchman is high, but labour is very dear in Tuticorin, and the men will have to be nursery-men rather than mere watchers.

I recommend that the farm be sanctioned at a very early date and the cost met from the lump sum Rs. 15,000 provided in the current year's budget.

ORDER—NO. 1314, REVENUE, DATED 2ND MAY 1912.

The Government approve of Mr. Hornell's proposals for the establishment of an experimental marine fishfarm near Tuticorin and sanction an expenditure of Rs. 4,700 to meet the capital cost and the running expenses during the current year in connection with the farm.*

* Various uncontrollable delays have occurred in constructing this fish-farm, but it was built at the end of 1914 and has now (1915) begun work.

Letter—from Sir F. A. Nicholson, K.C.I.E., I.C.S., Honorary Director, Madras Fisheries.
Dated—Madras, the 31st May 1911.

I have the honour to request that Government will be pleased to consider the following letter when deciding upon the plan, etc., of the new aquarium at Madras. My letter is almost entirely based on suggestions made to me by Mr. Hornell as Marine Assistant to "Fisheries", and discussed together both in person and by letter; as expert member of the Aquarium Committee Mr. Hornell drew up the general plans and suggestions for the new aquarium, and in so doing proposed that with the living exhibition should be combined a place of study and education, and a proper home for the Fisheries Department. I append copies from Mr. Hornell's letters.

2. I suggest (*a*) that the new aquarium should not be merely a show place, for recreation or for the satisfaction of curiosity even though intelligent, but that it should be (1) scientific, (2) educational, (3) practical; (*b*) that the direct association of "Fisheries" with the aquarium will be for the financial, administrative and practical benefit of both.

3. A modern aquarium is as much a marine biological station as a mere place for the exhibition, however interesting, of the wonders of the deep; it is now usual to combine both purposes. The Naples Aquarium is, of course, the standing and finest example of such a combination, and for forty years has been the resort on the one hand of the tourist and general visitor, on the other of the student and savant, while its specimens have gone all over the world. This is similarly the case with the Aquaria of the United States, their latest being under development in the Philippines; so also at Plymouth in England, Monaco, etc. The New York Aquarium, already second in the world, is to be developed on both sides at an expense running into millions of dollars. I therefore presume that when undertaking the expense of a large new aquarium, Madras will not neglect the practically universal example of other countries, specially under the considerations which follow.

4. *Scientific*.—There is no marine biological station, as distinguished from museums, between Naples and Japan except perhaps a small station for special purposes

at Galle ; the contents and biology of the tropical waters of the Near and Middle East are scientifically almost unexplored ; we know almost nothing of marine zoology in its many *living* aspects as apart from mere descriptive and classificatory work. Apart from the aid which science may and does give to practical work, there ought to be in this great country, the very centre of the tropical East, a central station, where the marine fisheries staff and where savants and students of marine biology can study marine life, both fauna and flora, not as mere museum specimens but as living organisms. Moreover, savants from Europe, *e.g.*, from Oxford, frequently desire material for biological research, which, for lack of a supplying agency, they are unable to procure. I need not, however, dwell on this point, since it will obviously be admitted ; it is rather a question of finance and location.

5. *Educational.*—There can be no two opinions as to the need for such a station as an aid and adjunct to education in natural history. As pointed out by Mr. Hornell, and by Professor Powell of Bombay in the appended extract from the *Madras Mail*, biological students must, in the absence of specimens, even dead ones, be mere text-book men, who may have committed to memory printed descriptions and facts gathered by scientists but who have no first-hand acquaintance with the organisms they describe ; they have never seen or handled a cray fish but can quote Huxley *verbatim* ; they have not studied science but only the literature of science. Consequently educationists all over the country are demanding sets of specimens for their students to handle and examine ; Mr. Hornell has been asked by various educationists, *e.g.*, the Victoria College at Palghat, for sets of specimens which he is, of course, unable to supply ; the Acting Director of Public Instruction considers that sets of properly preserved specimens of marine fauna would be of great benefit to college and school museums. This duty of providing properly arranged series of fauna for educational purposes is very thoroughly carried out by the Fisheries Department of the United States of America and to a great extent by biological stations in other countries. *A fortiori*, a marine station where college students can study, as living organisms, the fauna and flora which their text-books describe, can observe, handle, and dissect them,

will be of first-class educational importance. Professor Powell of Bombay considers that it would be difficult to exaggerate the importance of a properly equipped aquarium as an educational factor. A proper biological laboratory added to the exhibition and opportunities of study afforded by the aquarium would supply sets of specimens for the whole of India and to many other places, while providing a place of study from the life, as in other countries.

6. *Practical.*—An aquarium which is at the same time a biological station would be of great *practical* importance, especially to the "Fisheries" staff. Marine fish-farming, for instance, can hardly be undertaken successfully or without much loss of time and money, until we know at least something of the breeding and feeding habits or characteristics of food-fishes on which, at present, we know absolutely nothing; these points could be readily studied in an aquarium properly equipped for such studies and continuously available to Fishery officers. Similarly it would be possible for experts to study and probably ascertain the method of inducing the pearl oyster to produce pearls; as I have pointed out in my Note on Japanese Fisheries, it was by study at the coastal biological station that Professor Mitsukuri was led to suggest to a business man a method of inducing pearl growth, a method which, though only growing half or three-quarter pearls, has brought lakhs of rupees of profit to Japanese pearl-growers. From further re-searches it is possible, perhaps probable, that a method of growing whole or round pearls may be developed, and in Mr. Hornell we have an expert capable of tackling the problem which scientists elsewhere are attempting. So also the bionomics of chanks could be readily studied, a necessary preliminary to a culture which must prove of direct pecuniary gain to Government and others. There are many other practical matters which could advantageously be studied in an aquarium which includes a properly equipped biological laboratory.

7. I conclude point (*a*) by suggesting that Madras is the proper place for a combined aquarium and biological station for scientific, educational and practical work. The Presidency has the longest sea-board of any province; it is washed both by the Bay of Bengal and by the Indian Ocean, and is completely tropical. Moreover,

Madras has the honour of having led the way throughout in fishery work ; Dr. Day was a Madras man, first employed by the then Madras Government to study its fisheries ; later on (1905) the Madras Government revived the subject and instituted investigations which are not only bearing local results but have been elsewhere followed. Madras established the first tropical aquarium —except that in Honolulu—and has already shown therein some of the wonderful animals which live in its waters ; now that the aquarium is to be developed in size it should also be developed in scope, in importance, and in usefulness.

8. (*b*) *The direct association of "Fisheries" with the aquarium and its advantages.*—Mr. Hornell, in his revised plan, suggests that the whole upper storey of the new aquarium should be the home of the Fisheries Department. He proposes that the upper storey should comprise a good laboratory, a technical museum and library for the use of students and staff, and office rooms, the whole of the ground floor being devoted to the aquarium proper. The proposal connotes a direct connection of the Fisheries Department with the administration and working of the aquarium. I consider, with Mr. Hornell, that the connection will be for the financial, administrative and practical benefit both of the aquarium proper, of the Fisheries Department, and of special education for staff and students.

9. At present "Fisheries" has not even a habitation, still less a laboratory or biological equipment as in all other countries, except Great Britain where the Fishery Departments are mainly for statistical or regulative purposes. We have in Madras a couple of rooms which are all very well so long as the office is a mere clerical staff engaged in keeping accounts and writing letters ; the Cannanore station is concerned with manufacturing questions, and Tuticorin with pearls and chanks. But if investigation work, including both scientific research and practical experiment, and educational work in various branches, are to be carried on, even on the most modest scale, "Fisheries" must have a domicile. Moreover, for the educational work mentioned in paragraph 5 *supra*, viz., the preparation and issue of complete sets of zoological specimens for the use of colleges, schools, museums, savants and students,

and for the issue to scientific persons or bodies of such material as they may occasionally require, a proper domicile is necessary, since "Fisheries" alone can fill this demand which is daily growing.

10. *Advantages to "Fisheries."*—(*a*) Economy in the provision of a fitting domicile at minimum cost. I presume that addition of an upper storey to the aquarium building will not only be much less costly than the erection of a separate building, but will add *materially* to its architectural appearance; hence economy in cost. But for investigation purposes "Fisheries" would require the provision of live tanks for its numerous experiments (e.g.), in the feeding and breeding of fish, the treatment of shell fish not only for pearl breeding but for shell industries, etc.), and in the aquarium these will already be provided on a large scale, hence a second and very great economy. This latter consideration is bound up with (*b*), viz., the immense advantages to Fisheries of a splendid series of live tanks for observation and experiment, and with (*c*), viz., the ability to prepare sets of specimens for educational and scientific work by the Fisheries staff working in the laboratory which is the essential part of the proposed Fisheries office. A fourth advantage (*d*) is that many chemical and physical analyses and experiments could be conducted there for which, at present, I have absolutely no provision, and which are of the first importance, such, for instance, as laboratory experiments in the refining, bleaching, and decolorizing of fish-oil by chemical and physical methods, the valuation of fish guano by the ascertainment of its nitrogen and phosphoric acid contents, the examination of samples of fish treated with various amounts of preservatives, in view to ascertain the amount actually absorbed or remaining, a matter of the very first necessity, and many other researches which I need not detail; these could all be dealt with by an Indian Assistant or Sub-Assistant at slight expense in a small laboratory fitted *ad hoc*. A fifth advantage (*e*) would be the provision of accommodation for the growing scientific library of the department in an *accessible* and convenient place, coupled with a small technical museum as I have seen both in Japan and in Washington, both being for the consultation and education of the staff and of students.

11. *Advantages to the aquarium.*—A primary advantage (*a*) is that experts of the Fisheries staff would be always on the spot, either the Marine Assistant himself, or one of the others. These would not only give general supervision, but would materially assist in the practical working of the aquarium, a matter in which many questions or difficulties must constantly arise when a large series of living animals are associated in somewhat abnormal conditions, and when questions of food, air, water circulation, etc., must constantly arise. Here, again, would result considerable economy, since in the absence of such experts, always on the spot, separate aquarium officers would have to be appointed at considerable expense, and I need hardly say that none could easily or cheaply be obtained who would have the experience and the knowledge of the higher officers of "Fisheries," such as Mr. Hornell himself. A second advantage (*b*) is that "Fisheries" could greatly aid and greatly cheapen the provision of live or other material. We already have two fishing boats, one of which, the motor-boat "Turbinella," will use powerful nets and dredges, and could provide the aquarium with any quantity and variety of specimens. I understand that the local fishermen utterly refuse to provide food-fishes (probably fearing that we shall breed them on an enormous scale and abolish the fishermen, as gravely suggested in a recent petition to Government), and that, in fact, there are none in the present aquarium; these we could provide in any quantity as well as sharks, etc., about which there is a local difficulty. The "Turbinella" will probably be stationed at Madras, and when the proposed new inspection schooner becomes available the aquarium could have almost whatever it chose at practically no expense and on demand.

12. *Advantages to the public.*—Apart from the special educational advantage alluded to in paragraph 10 (*c*), viz., the distribution of specimens and material for education and research, there would be the great advantage to the general public that, with Fisheries located in the aquarium building and constantly examining the tanks, there would be on the spot expert officers ready and able to give detailed and interesting information which would *immensely* add to the attractions of the place as a show, and would often convert mere gaping

curiosity into intelligent observation. Apart from actual students, the more intelligent or earnest enquirers would readily be given permission to observe in the upper storey laboratory processes and results, and to consult the technical library or museum of models and implements, so that the aquarium would become an educational institution of much practical value, and one which might become the nucleus of a general Fisheries Association and of a Fisheries school.

13. I beg, therefore, to commend to Government the proposal to locate Fisheries in the upper storey of the new aquarium, and to provide it, at very moderate expense, with such laboratory and other facilities as will enable us to obtain the above advantages for the aquarium, for the department and for the public.

The above letter was referred by G.O. No. 2336, Revenue, dated 1st August 1911, to a committee mainly of scientists who reported as below.

Letter—from the Chairman and Members of the Committee appointed to report on the proposals regarding the projected new Aquarium for Madras.
Dated—the 16th January 1912.

In accordance with the direction contained in G.O. No. 2336, Revenue, dated 1st August 1911, the committee therein appointed met this day under the chairmanship of Dr. A. G. Bourne, F.R.S., to consider the suggestions made by Sir F. Nicholson in his letter of 31st May 1911 regarding the enlargement of the scope and usefulness of the new Marine Aquarium which it is proposed to build in Madras.

2. We the undersigned members of this Committee are unanimous in expressing our entire approval of the scheme and have little to add to the proposals.

3. The association of the management of the Aquarium with the Fisheries Department is an obvious desirability, and it will be an arrangement both economical and of great practical advantage if one of the officers of the department named be *ex-officio* the Director of the new institution.

4. The interests of the Fisheries Department require that the location of their head-quarters should be at Madras, but were there no compensating advantages such as those which will be conferred (*a*) by the utilisation of the fishery investigation vessel and the fishery motor-boats for the supply of living material for the aquarium tanks and for biological research, and (*b*) by the use of the Fishery out-stations at Tuticorin and elsewhere, Madras would not be the most suitable location for a Marine Biological station. The Committee are of opinion that if arrangements be made to afford opportunity for biological research at the Tuticorin Fishery station and particularly if special provision be made eventually for the opening of a small Biological out-station at Pamban where research on a rich coral reef fauna and flora may be prosecuted with great facility, then the disadvantage inherent in the Madras location will be counterbalanced. The provision of research facilities at Tuticorin will involve no extra expenditure as the Fishery Department already maintains an establishment there.

The desirability also of fully investigating local freshwater piscicultural problems further points to

Madras as the most generally convenient and suitable working centre.

5. The staff, additional to that of the Fisheries Department, which we consider requisite for the working of the main institution in Madras is as follows:—

One Zoological Assistant and one Chemical Assistant, each on a salary of Rs. 100–5–150, one Research Fellow employed upon fishery investigation (tenable by graduates of the Madras University) on Rs. 50 per mensem, together with a subordinate staff of two door-keepers, one engineer, one engineer's assistant, three laboratory and aquarium attendants, two fishermen, one gardener and one sweeper. This staff as shown in the annexure will involve an expenditure of Rs. 5,640 per annum. In the same annexure the estimated cost of upkeep and contingencies is shown as Rs. 6,660 per annum, being a total annual expenditure of Rs. 12,300 in round figures.

ORDER—NO. 756, REVENUE, DATED 13TH MARCH 1913.

The Government have for some time past had under their consideration the necessity of enlarging the scope of the Marine Aquarium in Madras and of providing additional facilities for research work in Marine Biology and allied subjects to meet the growing needs of the Department of Fisheries, and of students and others interested in such research. In January 1911, Mr. Hornell was directed to draw up in consultation with the Superintendent, Government Museum, a scheme for the internal arrangements of a new Aquarium, which it was proposed to construct, and in his letter, dated 31st May 1911, Sir F. Nicholson submitted to Government his suggestions as to the scientific, educational and practical requirements for which the new Aquarium should provide. He also suggested that the combined Aquarium and Biological station which he thus proposed to institute should be placed under the control of the Fisheries Department, which should be accommodated in the building, and that provision for a laboratory, a technical museum and library should be made. The Government accordingly appointed a Committee composed of four officers of the Fisheries

and Educational Departments, to consider and report on these suggestions and to draw up detailed estimates as to the establishment that would be required and as to the cost that would be involved.

2. The fourth paper read above is the Report of the Committee thus formed. The members are unanimously in support of the scheme and of the recommendation that the management of the Aquarium should be entrusted to the Department of Fisheries.

3. His Excellency the Governor in Council is accordingly pleased to approve the recommendations of the Committee and to sanction the construction of a new combined Marine Aquarium and Biological station at an estimated cost of Rupees two lakhs, and to sanction the estimate of recurring expenditure, amounting to Rs. 12,300 per annum, as shown in the annexure to the Committee's report. Orders will issue in the Public Works Department for the preparation of detailed plans and estimates for the work.

4. The Government are also pleased to direct that the control and management of the Aquarium be transferred from the Educational to the Fisheries Department, and that the Marine Assistant and Superintendent of Pearl and Chank Fisheries be, *ex-officio*, the Director of the combined Marine Aquarium and Biological station.*

* The plans of the Biological station and Aquarium are now under preparation by the Government Architect and should result in a very fine institution both scientifically and architecturally.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., I.C.S., Honorary Director of Fisheries.
Dated—Madras, the 23rd December 1912.

I have the honour to submit remarks on the second sub-paragraph of paragraph 5 in G.O. No. 2638, Revenue of 3rd September, reviewing my report for 1911–1912.

2. The sub-paragraph instructs me in future to report (*a*) "the amount of fish products placed on the market by the department."

3. *Point* (*a*).—This raises the whole question of industrial and commercial, as against experimental, work, to which I referred at length in paragraph 19 of my report for 1909-10, and again in my report for 1910–11. Hitherto our work, beginning at first with investigation, has been experimental, viz., attempts to ascertain the technical methods most suitable to our fish and in our climate; to adapt Western processes to our conditions. We have now obtained such an amount of technical success and experience that we can take the further step of translating experimental into industrial work, the obvious and necessary complement to which is commercial work, viz., the sale of the goods industrially produced.

It is only by placing goods on the market as a business proposition that we can either test their acceptability or their profitableness. By the experience we have gained we *can* now supply untainted fish in all lines; we *can* provide light-cured, semi-dried, pilchardized, pickled, smoked, and canned products not one of which has hitherto been commercially on the market, and it is not possible to gauge the public tastes—especially in different localities and communities—without providing a supply on a fairly large, continuous, and reliable scale. Hence technical success such as we have gained, is only a first success; we have now to ascertain whether our technically successful products meet the public tastes, and where modifications may be desirable, and of what sort. Moreover, the main point in establishing a new industry—or at all events new lines of goods—is whether they can be produced and sold profitably; profit is the touchstone of industrial success for it is only profit which, at one and the same time,

demonstrates technical success, public acceptability, and the necessary return on capital ; profit can only be demonstrated by entering the business market as producers and sellers ; and it is only upon the demonstration of profit—as in our commercially successful fish oil and guano manufacture—that private enterprise and capital will pay any serious attention to the new methods and to developing the industry. Finally it is essential to advertise, that is to make known, the methods and their results ; reports written to Government are valueless to the business public who will not believe them *per se* ; they must see results ; reports may lie, but products at all events are solid facts. Products, moreover, exhibited for sale in a shop or stall are advertisements which cannot only be seen but handled and tasted, and will do more to create a demand than a thousand reports. Hence Government must pioneer not only technical but commercial work in this industry.

4. But with our experimental plant and staff we cannot go into the market in business fashion ; our small plant, staff, and organization are not adapted to industrial work. What I can do with technical success I cannot at this moment do with commercial success, because my plant and staff are insufficient in size and organization to produce an industrial output ; commercial success requires, moreover, that the goods shall be produced in a businesslike way, and further, that they shall be up-to-date, attractive, and cheap though commercially profitable. All this I can do if now provided with the necessary plant, which has partly been indicated by my studies in England, etc., this year.

5. I have refrained from coming forward with direct industrial proposals till I was quite sure of the best methods and products ; hasty efforts by ill-equipped persons kill an infant industry, and there have been notably bad results from premature attempts. Moreover, there were several genuine attempts by private enterprise—at one time three persons or syndicates—to take up certain branches of curing, and I stood aside so as not to interfere ; two out of those three have now dropped out, and the third enterprise is insufficient and petty. Nor can I now regard enterprise which merely takes up the "casual parcel" class of work as a serious attempt to develop a modern fish-curing industry ; such

enterprise is usually lacking in capital and in organization, and fails the moment a demand for continuous supplies arises. Hence I consider that the Government department should take up the matter in a business fashion, always with the proviso that it will relinquish commercial work when private enterprise *seriously* enters on it. I may remind Government that in Japan it was the Government experimental fishery stations which developed the large modern fishing industries, especially those of canning, modern curing, oil and guano, etc., by taking up the several branches industrially and commercially, and entering the market as serious producers (see my note on Japanese Fisheries); also that at the Industrial Conference at Ootacamund several years ago, "Fisheries" were expressly excluded from the category of industries in which the intervention of Government was deprecated; in "fisheries" a free hand was willingly conceded to Government, just because private enterprise was unlikely to take the matter up till Government had demonstrated profitable possibilities.

I now propose to ask the sanction of Government (1) for new plant proper for industrial work, if only as a model or type for future potential manufacturers; (2) to put the resulting products on the market for pioneering purposes only.

6. *New plant needed for certain branches of work.*—I will consider in detail several of the processes and products and indicate the new plant which I consider immediately necessary, e.g.—

(1) Canning.
(2) Light curing.
(3) Pickling.
(4) Fresh fish supply.
(5) Net making.

7. *Canning.*—This promises to be one of our earliest and easiest successes though our latest experiment, just because the goods can be easily and openly displayed as new and attractive products, readily saleable everywhere and to all, and at cheap rates. The outlay on plant for the production of really attractive goods must be somewhat large, but should recoup itself at once, and the plant would be readily saleable to a purchaser.

One of my chief and most costly difficulties at Calicut has been trustworthy soldering, especially where goods are preserved otherwise than in oil. Moreover our tins, though solid and good, are not so attractive as the

modern make of cans, and the soldering process is slow and costly. In a soldered can (1) the body has to be cut and soldered together, (2) the bottom has to be struck and soldered to the body, (3) after the can is filled the top, separately struck, has to be soldered on. Hence three solderings in each of which there may be a defect, nor is the completed can attractive till supplied with paper or foil labels. Moreover our solderers are apt to work very slowly and unless under the strictest supervision, inefficiently. But the modern can is (1) solid drawn, viz., by being stamped by a die out of the flat into a seamless dish, (2) the cover is sealed on to the body by a machine which folds the edges or flanges of cover and body with a double fold having a rubber ring between them, so that the joint is not only beautifully neat but absolutely air-tight, the operation is practically automatic, is extremely rapid—over 5,000 per day can be sealed with one machine—failures are very few, and the completed can is of good appearance, being extremely neat and tidy, irrespective of the labels.

8. Schedule A is a pro formâ invoice of a can-making plant which I propose as a type-plant, viz., an installation which can at any moment be reproduced by persons who desire to engage in canning as a business enterprise, and who can simply copy our plant and be instructed in every detail of its use, larger enterprise can simply multiply the units of which it is composed or obtain larger machines of the same type. This will greatly help private enterprise in taking up what must, at a very early date, become a popular industry, by having a type plant people can know beforehand exactly the cost of an enterprise and can be personally instructed in its use, while repairs and replacements will be immensely simplified. The engineers who supply the plant have gone carefully into the matter with me, and the plant is believed to be exactly suitable for the small canneries which, like the small oil and guano factories, will probably be the form which development will take.

For purposes in which solderless cans are undesirable, whether on account of small size or other technical reasons, I shall still have my present plant which is quite efficient.

Canning plant is not required as the cannery already possesses a boiler, steam bath, steam cooking retort, and an autoclave, besides experimental plant, any small developments can be supplied from the ordinary current grant for plant.

9. I therefore suggest that my purchase of the plant mentioned in schedule A at a cost of about £400 be sanctioned, and that I may be permitted to set it up and work the cannery as an industrial concern.*

11. *Light curing.*—For this I require only small outlay, since I have nearly everything necessary except drying plant. As I have frequently mentioned, the tropical sun is not good for the proper drying of edible fish, at least when whole; moreover, in the monsoon time fish, prawns, etc., cannot be dried for want of sun so that either it is not worth while to catch them, or, if caught, they go bad for want of drying, while in any case the fishermen get a bad price because the curers cannot certainly count on drying them. I have known boatloads of valuable prawns sold for a trifle because the curers would not take the risks due to wet weather. Moreover, in light curing the drying is only carried to a certain stage so that the heat and method must be capable of easy regulation and while partial must be fairly equal throughout the tissues, instead of being on the surface only; hence the drying plant must be something else than the burning sun.

Proper driers, in which dryage is obtained by mechanical arrangements, will effect the above reforms, and I propose to set up driers of one or two quite cheap but effective patterns, which may be everywhere copied, and which may especially be set up in the numerous Government "curing yards" for use in common by ticket holders.

I request sanction to lay out a special sum not exceeding £75 in plant for the drying of edible fish, that is exclusive of a different class of drier for fish-guano.

12. *Pickling.*—The only special outlay in this matter is on barrels and coopering. At present I must obtain my barrels from England; they will cost me about three shillings each, and will be sent out in shooks so as to minimize freight; the staves will be all marked so that

* Obtained and set up (1915) at Beypore.

they may be readily assembled by one cooper. I have also need of a set of coopering tools for use in the curing yard; my carpenter is a fair cooper. After we have obtained a supply of proper barrels made of the proper wood I will try and have similar barrels made locally. I request sanction for expending a special sum not exceeding £50 (Rs. 750) on this account.

13. *Fresh fish supply.*—Hitherto I have not developed this important and attractive branch but have confined myself to cured fish, since the supply of fresh fish demands considerable organization (especially for sale) and somewhat expensive plant. But it is, of all branches, that which most appeals to the public and about which there is no question of varying taste or doubtful acceptability; no one will look at cured fish if fresh fish can be obtained; this is strikingly shown not by mere verbal demands but by the facts—

(1) that it is usual to try and sell all fish fresh before it is taken to the curing yards where it consequently arrives, often, in a state of incipient taint,

(2) an inland trade is carried on by runners chiefly but occasionally by train and jutka, to the utmost possible limit—possible that is to utterly crude and careless methods—and in villages a very few miles from the coast, fish is habitually consumed as "fresh," i.e., not cured fish, though its condition is very far indeed from freshness, and I cannot but think that many of the cases of the bowel and other complaints are due to the eating of decomposing fish which is notoriously toxic especially in the earlier stages of decomposition.

Moreover there has existed for many years a so-called fresh fish trade in which fish in ice are sent by the night mails to certain markets, such as Ootacamund, Coonoor and Bangalore, in which this fish is sold at high prices, but not always in the best condition. Having watched the present unsatisfactory methods from the beach at Pulicat and Ennore to the tables in Ootacamund where so-called "fresh" fish is served up, and having failed to induce West Coast merchants to take up the matter seriously though there is a small ice factory at Calicut, I think it time to enter the market with new methods based on scientific practice, and I believe that I can put fresh, firm fish from Malabar on the market in Ootacamund, Bangalore and Madras at

cheaper rates than are now paid for soft pasty fish, rates which will open up a much larger demand and a wider market, by methods of much simplicity, which I have been studying in actual practice in England.

14. Apart from the fresh fish business, moreover, a refrigerating plant is necessary to our developed methods such as canning. It frequently happens, almost daily in fact, that the best catches are made or come to shore in the afternoon, when it is too late to work off more than part of the fish or to get through more than some of the stages of curing or canning. For instance, prawns may come in in bulk at 3 P.M. and it is late before they can even be boiled and shelled while, if left till next morning, they will be stale and sour; similarly sardines may be only half prepared for canning. Unless therefore in the absence of a refrigerating plant, I have a night staff and night superintendent I run the greatest risks, and in small industrial factories run for the maximum of profit, manufacturers might often be tempted to use up stale goods rather than incur loss; hence risk to the public unless I demonstrate that, with a small outlay on refrigeration, goods can be kept over night or longer with complete safety. Again sardines, mackerel, etc., come in in bulk one day and glut the market, while next day there are none at any price. Hence to equalize demand, prices and factory work, a refrigerating plant is a necessity, especially where we are trying to develop modern methods and the potentially great fishing industry.

15. My method of transporting fresh fish and the need for preserving fish in cold storage for a day or two require a small refrigerating—not an ice-making—plant; small, because our operations, though on an industrial scale, will necessarily be small; an ammonia plant of about 1 ton refrigerating capacity will suffice, and this, delivered and set up, will cost about £400 (Rs. 6,000) including a small oil-engine, cold storage room, etc. I recommend this for sanction.*

16. *Net-making.*—Our experimental stations are really our future educational institutions where modern processes will be taught to fishermen, curers, students and youth on the lines which I saw so successfully practised in Japan (see "Note on Japanese Fisheries").

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* A smaller plant costing about £140 has been obtained, chiefly for working the "Henderson" process of fish freezing and transport.

One of the most practical subjects and one which can especially be taught to youth is *net-making*. At present this is practised on the primitive lines of village cloth-weaving ; even more primitive indeed, for village weaving possesses hand-looms while the net-makers have none, but squat on the beach and slowly make their nets by hand. The increasing demand for sardines for manure and other fish for food leads to an increased demand for nets, and I have had painful experience of the extreme difficulty of getting nets, while the fishermen occupy many months in making their own. My Personal Assistant, Mr. V. Govindan, often brought this to notice on the West Coast, and while travelling in Scotland and Ireland he discovered and brought to my notice that net-making looms *worked by hand* are available and are in regular use ; they have been supplied to the Government Fishery school at Baltimore (Ireland) and are exported to the Colonies, etc., and I have myself inspected a net-making factory in Cornwall where pilchard, herring and mackerel nets are being made on six or seven hand-looms. On consideration of the various looms I have selected those made by a manufacturer at Bridport (Dorset) (a very well-known centre of net-making by power-looms), who made the hand-looms which I saw in Cornwall and have obtained through Mr. Govindan, who has especially studied this item of the industry and has visited several factories, a pro formâ invoice of his looms. The cost of one loom will be £170, and with accessories and packing, etc., about £200. A loom will, within reasonable ranges, make varying sizes of meshes, e.g., between 36 and 64 per yard, so that two looms would supply all needs, but at present I only ask for one. The maker will not only give Mr. Govindan free and full instruction in working the machine, but also in re-assembling it from the packing cases, and in dealing with anything that may go wrong, for which purpose not only will every part be clearly numbered and marked, but the loom will be taken to pieces and re-assembled until Mr. Govindan is thoroughly conversant with it ; three or four weeks will be advisable for this tuition, and this is one of the reasons for my having recommended an extension of his deputation till 31st March. Any further aid we can get from experts in the cotton-weaving mill in Calicut.

This one loom will make nets faster and better than a whole group of village netters, and will supply the experimental station with its ness, will serve as a pattern plant for others who may wish to invest in such machines (we have had enquirers on the coast), and will enable us to instruct apprentices in the working of the most useful machines.

I therefore ask sanction for buying one hand-worked netting loom and accessories at an approximate cost of £200 *plus* freight, from Messrs. Richard Samson of Bridport.*

17. *Deep-sea fishing.*—I reserve my recommendation on this essential matter till I return to India in January, as it does not involve immediate purchases, merely premising that by "*deep-sea fishing*," I here mean the charter or purchase of a large sailing boat, of say 50 or 60 tons, for use as indicated in paragraphs 7 to 18 of my letter No. 55 of May 1908, with our existing motor boat ("Pearl") as a carrier to the same. The master fisherman whose employment has already been sanctioned by Government, will skipper this boat, which will not be an expensive craft like the new inspection schooner, but a plain teak-built boat, built on the East Coast at about Rs. 150 per ton, all told, exclusive of nets.

18. I therefore request the very early sanction of Government—

(1) for a present expenditure of about £1,400 (Rs. 21,000) payable partly out of the current budget, partly out of that (lump allotment) for 1913–14, on new up-to-date plant and accommodation for can-making and canning, light curing, pickling, refrigerating, and net-making ;

(2) for permission to work the experimental station in all branches as an industrial concern but only—

(*a*) until the products have created an effective demand for themselves ;

(*b*) until private enterprise has seriously and effectively taken up the supply of such products ; and

(*c*) until we have thoroughly instructed so many students and manufacturers in the various operations that the new fishery industry can march by itself free from the monopolies due to trade secrecy, and from the

* Obtained and set up in Tanur experimental station.

risks to the public due to half-knowledge and to imperfect methods and plant.

I should add that as the basis of the proposed development is, exhypothesi, commercial, the profits, if our work is successful, will form a return upon the above expenditure which is purely capital, non-recurring outlay.

ORDER—No. 537, REVENUE, DATED 20TH FEBRUARY 1913.

The Government are pleased to sanction the expenditure of Rs, 21,000 (Rs. 7,000 to be met from the current year's budget and the balance from that of 1913–14) on new up-to-date plant and accommodation for can-making and canning, light curing, pickling, refrigerating and net-making as proposed by the Honorary Director of Fisheries.

2. They also approve the Honorary Director's propcsal to work the experimental station in all branches as an industrial concern subject to the conditions specified in paragraph 18 (2) of his letter read above.

Letter—from Sir F. A. NICHOLSON, K.C.I.E., I.C.S., Honorary Director of Fisheries.
Dated—Madras, the 26th February 1913.

I have the honour to forward herewith a note on my recent inspection of the Sunkesula fish farm, as its facts may be of interest to Government.

SUNKESULA FISH FARM INSPECTION NOTE.

A note, based on recent inspection by the undersigned, on the character and work of the above fish farm, established by the Piscicultural Expert, Mr. H. C. Wilson, may be interesting, as it is the very first fish-farm established in Madras, possibly in India, except the same officer's trout hatchery on the Nilgiris; the accompanying blue print gives a complete plan of the farm.

2. It was established primarily (see note on Japanese Fisheries, paragraphs 203—205 and 211) to experiment in stocking the 200 miles of the Kurnool-Cuddapah canal (besides occasional large tanks) which are barren of fish except for the first 17 miles, though abounding in fish food. Hence its somewhat out-of-the-way position at the Canal anicut where alone it can get a supply of water—by pumping from the river—all the year round. Its gross area is 20·05 acres, and it contains roughly $10\frac{3}{4}$ acres of water, divided into 19 ponds, the largest of which is about 4 acres. The farm lies below the flood bank of the river from which water is pumped by a small steam engine running a six-inch Gwynne centrifugal, for about eight hours per day, but not necessarily daily. The water passes into a settling and storage reservoir, whence after depositing much of its mud, it flows to the several ponds; after having done its work in the ponds it flows by a low level sluice into a small wet dock for the motor boat and then into the canal on which one extremity abuts. The work of laying out the ponds has been done in a very systematic and workmanlike manner; every pond can be supplied or cut off independently, by means of sluices in the common channels, and there are alternative channels in case of a breakdown and for other reasons. The ponds are excavated and embanked in a substantial manner and the whole farm fenced in. More land is available if it should be thought necessary to extend the area, e g., for growing cholam, etc., as food for the carp.

3. The farm has an oil-launch and a number of live-cars for transporting the fish to various sections of the canal; the launch engine has given trouble but the reasons have been discovered and it is now likely to do well. But it is not quite powerful enough to tow a string of live-cars against the full current, which runs at about three miles per hour, and a new engine may be necessary; the old one can readily be utilised elsewhere. A house boat is desirable, as the Piscicultural Expert has to depend on borrowing from the Public Works Department and boats are often not available, and not comfortable.

There is a general superintendent on Rs. 50 (the incumbent is a pensioned Subadar Major), a writer-maistry, an engine driver and assistant, six fishermen, and a watchman; the Piscicultural Expert constantly visits the farm.

4. An integral and necessary part of the farm, though five or six miles distant, is the large Edurur swamp, an area of several hundred acres; this is a large sheet of shallow water fed partly from the canal into which it opens, partly by the drainage from the surrounding country. It is mostly covered by reeds and grass, but there is a large area of open water in the middle; the vegetation of course provides enormous amounts of fish food, besides protection for the young fish. The swamp holds water for about eleven months in the year, drying up soon after the canal is closed. In this swamp vast numbers of young fish are placed to grow, means being, of course, devised to remove the fish before the water entirely disappears; for full utilisation this swamp will be further developed, e.g., by excavating a small area in the deep bed to which all fish will resort as the shallower parts dry up and in which they may readily be netted for removal to the farm proper during the short dry season.

5. The farm has at present three objects, two main and the third subsidiary, viz., (1) carp growing for stocking the canal and other waters; (2) murrel growing for the market; (3) the growing of larvicides for the destruction of mosquito larvæ.

6. *Carp growing.*—This in principle is a very simple matter though it requires very careful work in practice. A number of mature fish (spawners) have been obtained and placed in several of the ponds; here they spawn in

the reeds and grass surrounding the ponds ; the fry and spawners are separated after a time so that the young ones may feed and grow undisturbed. Before the canal closes in April a number of fry are also obtained from the river, and the young fish from the Edurur swamp are also brought in. Here they are kept until June-July when, the canal being again open, the young fish (fingerlings and upward) are removed in the live-cars to various sections of the canal. This was done for the first time in 1912 but only about 40 miles were stocked and that only partially, as the farm was not fairly at work.

7. Obviously recourse must be had to artificial feeding except in the Edurur swamp where there is abundance of space and natural food. In the farm proper fish have to be fed, principally with cholam grain, boiled and mixed with soil into balls, which are then broken up and distributed over the ponds. The question of the nature and cost of food is being further considered by Mr. Wilson.

8. One pond was netted for my inspection and showed a good head of fine fish (*Catla Buchanani*) ; a small one had some vigorous mahseer (*Barbus Tor*) of fair size.

9. The work of stocking the canal and tanks has hardly yet begun ; next season (from July onwards) this work, will be much more advanced. But the farm proper is organized and equipped for doing excellent work, though additions and developments are still necessary.

10. *Murrel farm.*—This branch of work is an excellent illustration of the economic value of the practical knowledge of an expert. In studying the fish most useful for growth as human food Mr. Wilson was especially led to consider the murrel (*Ophiocephalus punctatus* and *srtiatus*) found all over the Presidency, especially in the irrigation tanks in which it is enabled to survive by its habits of æstivating deep down in the mud when the tanks dry up, and by its being an air breather. It is a fish which nests and vigorously protects its young for several months ; Mr. Wilson found that its eggs float and can consequently be easily removed by dippers from the nest and placed in protecting boxes where they hatch out ; after they have absorbed their yolk-sac they are let out from the boxes into the nursery pond where they grow undisturbed, proceed thence to a growing pond,

and finally when of fair growth, to the large market ponds where they mature. As these market ponds contain the mature fish a large number of murrel are hatched independently by the parents and tend to increase the stock of fish and, incidentally, of food for the larger fish.

11. The murrel being predaceous are of course kept in separate ponds away from the carp. The market ponds being large and almost covered with vegetation, the fish find an enormous amount of food for themselves in the shape of frogs, snails, water-beetles, insects, etc., but their natural feeding is supplemented by an artificial growth of frogs for which separate ponds have been allotted; here the frogs grow in countless numbers, and are daily collected and fed to the murrel.

12. The large market ponds aggregating over $2\frac{1}{2}$ acres simply swarm with fish of which there must be many thousands. These ponds are called "market ponds" for the following reason: Mr. Wilson ascertained (1) the ease with which these fish can be grown in any quantity, (2) the partiality of the public for them, especially when grown in clean ponds so that any muddy flavour disappears, (3) the extraordinary ease with which, as air breathers of persistent vitality, they survive removal from the water for many hours if kept merely moist, (4) the miserable nature of the fish supply in Kurnool town and villages (as in all inland districts). Hence he decided to grow murrel extensively not for placing in the canal, etc., but for market supply, and Government have practically sanctioned the building at Kurnool of a market stall with masonry live tanks at a cost of Rs. 550.

13. The site for this stall is close by the canal; an irrigation stream runs alongside it, and the water will be simply diverted through the live tanks in which the fish will be placed, and out again, without the slightest loss to the irrigation stream. The tanks will be sunk in the ground and a sluice already exists which will be utilized. The fish, brought from the farm in live cars along the canal, will be placed alive in these tanks, and kept alive till sold. It will be unnecessary to bring them while the canal is closed since at that time Kurnool is supplied with fish from the pools in the section of canal at Kurnool which, as above stated, is the only section containing an appreciable quantity of fish. The market

will supply a fair amount of fish regularly for the remainder of the year and cannot interfere with the fishermen's trade which is in general very petty and unproductive ; it will supplement this precarious supply by very desirable fish, alive till sold, consequently free from taint, and very nutritious. Mr. Wilson believes he can supply 20,000 murrel this year, and much greater numbers in the next and following years.

14. A third and subsidiary branch of work has recently been added, viz., that of the growth of larvicides for the destruction of mosquito larvæ. Glass tanks have been used and a small pond, and from the facts ascertained Mr. Wilson has now built a special pond for the growth of the fish which he has ascertained to be the best larvicides. On this subject he read a paper before the recent Malaria Conference.

15. To sum up : We have in Sunkesula the novelty (in India) of a working fish farm, its objects being—

(1) the stocking of barren waters to provide a new food supply ;

(2) the supply of live fish, grown for the purpose, direct to the markets ;

(3) the distribution of larvicides.

The *first* object is the increase of fish, in large quantities, which are to mature outside of the farm in waters at present almost barren of fish, viz., in the Kurnool-Cuddapah canal and elsewhere, but success or failure cannot be known for several years, viz., until the young fish have *for a series of seasons* been placed out in the canal and the results ascertained by enquiry, by observation, and by the rentals which at present are negligible except in the section near Kurnool town. The pecuniary returns to Government, if any, will only be indirect, viz., in the increased rentals derived from increased takes of fish all over the canal, but the increase in food supply should be very great. The object is an economic experiment.

The *second* object also aims at the production of large quantities of fish but in this case wholly within the farm ; the returns will be immediate and direct, and can be easily made not only to support the farm but to show good profits ; the main result, however, will be the practical ideas which this successful breeding of murrel suggests. To the department the success of murrel

breeding suggests that we should establish near each inland centre of population (e.g., Madura, Trichinopoly, Salem, etc.) a murrel farm purely for market supply, so that fish can be put on the market at a minimum cost of transport. These several farms, again, will provide object lessons to the public in the ideas and methods of fish breeding for profit wherever water can be secured.

The lessons of the *third* object of experiment enable us to devise means for establishing numerous centres for the growth and distribution of larvicidal fish and *por tanto*, the reduction of malarial disease.

Finally the existing farm, and still more those which will result from it, will form self-maintaining centres of piscicultural instruction both for our own staff and for the public who may be interested in profitable fish breeding. Sunkesula itself is necessarily somewhat out-of-the-way, but its facts and lessons can hereafter be demonstrated in centres accessible to all.

16. The conditions and methods for the practical cultivation of coarse fish on the Madras plains were, till the establishment of this farm, wholly unknown, and the difficulties very great, especially in this Presidency where the waters are everywhere temporary ; the binomics of the fresh water fish were little understood, and their artificial propagation had never been practised. Mr. Wilson is to be congratulated on this preliminary success which, as above stated, is an illustration of the economic success which only an expert can obtain where the conditions are novel, the difficulties unexplored, and the art locally unknown.

ORDER—NO. 1905, REVENUE, DATED 2ND JULY 1914.

In the above papers the Piscicultural Expert and the Honorary Director of Fisheries call attention to the necessity of prohibiting the use of basket traps and other fixed engines for fishing and of regulating the dimensions of fishing nets, with the object of protecting immature fish and particularly those which are useful as larvicides.

2. The Government accept their opinion that action in the directions suggested is desirable and is in fact urgently required in some parts of the Presidency in the interests both of the fishing industry and of the campaign against malaria; but they do not think that the general and immediate application of rules made under the Indian Fisheries Act to all public waters in the country, if indeed such general application were legal, would be prudent or desirable.

3. So far as regards the protection of fish in paddy fields and in private waters within the limits of zamindari and other estates, they consider that no direct action is possible, unless the owners concerned consent to the application of rules made under the Fisheries Act. But they desire that their officers should take every opportunity of impressing upon pattadars and landholders, the folly of methods of fishing which involve the needless destruction of small fry, and should use every endeavour to discourage them.

4. In public waters, e.g., rivers and channels registered as poramboke in ryotwari tracts, the Government will be prepared to apply rules framed under section 6 (3) of the Indian Fisheries Act, 1897, in particular cases when they are satisfied that such special measures of protection are required either for the protection of particular species of edible fish or for the establishment of larvicides in malarial tracts. But the particular waters to which the rules are to be applied must be specified by name, and information must be supplied of the existence of any claim to rights of exclusive, as opposed to common fishery, which if established would constitute any part of such waters, private waters, within the definition in section 3 of the Act.

5. Mr. Wilson will accordingly be requested to frame draft rules under section 6 (3) of the Act, or to supply the detailed particulars necessary to enable the Government

to frame them; and to specify the waters to which he recommends their application. His proposals should be supported by reasons in each case as indicated in the preceding paragraph and should be forwarded through the Collector of the district concerned.

6. Pending the application of such rules to particular waters, all officers of the Revenue and the Public Works Departments will be directed to take such action as they think practicable to prevent the use of fixed engines and the capture of immature fish. In all waters in which rights of fishery are let by Government the conditions of the lease should prohibit methods of fishing which are considered objectionable. In all waters registered as poramboke, the occupation of any portion of the bed by the erection of fixed engines or the construction of weirs should be treated as an encroachment and dealt with under section 6 of the Encroachments Act, 1905; unless the person in occupation of the bed can establish a customary right to so occupy it. In navigable waters persons who obstruct a public line of navigation by the erection of stake nets can be prosecuted under section 283 of the Indian Penal Code.

ORDER—NO. 1157, REVENUE, DATED 15TH MAY 1915.

The following notification will be published in the Fort St. George, Kistna, Cuddapah, Kurnool, Bellary, Tanjore, Trichinopoly, Salem, Nellore, Coimbatore, Malabar, South Canara and the Nilgiris District Gazettes:—

NOTIFICATION.

The following draft rules which His Excellency the Governor in Council proposes to make under section 6 of the Indian Fisheries Act, 1897, in respect of the waters specified below are published for general information. They will be taken into consideration after one month from the date of publication. Any representations regarding the same should be addressed to the Secretary to Government, Revenue Department:—

RULES.

1. No person shall erect or use any fixed engine or construct any weir for the purpose of catching fish in any of the following waters which is not 'private water':—

(1) the Kistna and the Tungabhadra rivers and their tributaries in the Kurnool district:

(2) the Tungabhadra river and its tributaries in the Bellary district:

(3) the Penner and its tributaries in the Cuddapah district:

(4) the Penner and the Kandleru (Upputeru) and their tributaries in the Nellore district :—

(5) the Upputeru and its tributaries and the Colair lake in the Kistna district :

(6) the Cauvery river and its tributaries in the Salem district :

(7) all the rivers and streams in the Nilgiri district :

(8) the Bhavani and the Moyar rivers and their tributaries in the Coimbatore district

(9) the Bhavani, the Ponnani, the Beypore (Karimpuzha) the Valarpattanam and the Talipparambha rivers and their tributaries in the Malabar district

(10) the Netravati, the Chandragiri, the Adkastala and the Charvattur rivers and their tributaries in the South Canara district

(11) the Cauvery river and its tributaries in the Trichinopoly district :

(12) the Coleroon river and its tributaries in the Tanjore district.

2. Any person who erects or uses any fixed engine or constructs any weir for the purpose of catching fish in any of the said waters in contravention of these rules shall be guilty of an offence and shall be liable, on conviction to a fine which may extend to Rs. 100, and if after such conviction he repeats the offence he shall be liable to a further fine which may extend to Rs. 10 for every day in which the offence is committed after the date of the first conviction.

3. A magistrate may, on conviction, order the seizure, forfeiture or removal of any fixed engines, erected or used in the commission of the offence and may also order the forfeiture of any fish taken by means of any such fixed engines or weirs.

The Marine Fisheries of the Madras Presidency.*

The Marine Fisheries of the Madras Presidency while of considerable present value, have much greater possibilities. The coast line of some 1,700 miles, exclusive of indentations, necessarily provides work for a large number of families, and food for many more, but the whole industry is still in a primitive condition; boats in general are either the catamaran (logs tied together) or the dug-out canoe; the area of fishing is limited to a distance not generally exceeding 5 or 6 miles from shore and 6 to 8 fathoms in depth; the nets and lines worked by such boats are necessarily of comparatively small power; and the duration of each voyage is but a few hours, usually by day but in some localities and seasons at night also. Curing methods are as primitive as the boats, being practically confined to salting and sun drying under conditions which render the product unacceptable to ordinary tastes and probably deleterious to health. Business organization is similarly crude, and the general ignorance of most of the fishing and even of the curing classes, is profound. The industry is, in a way, suited to physical conditions; where the surf is heavy, harbours few, and the open sandy beach the only landing place as along the East Coast generally, the catamaran is invaluable since it is unsinkable, can readily and safely be taken through the surf, the logs untied and carried up the beach; each separate log is also thoroughly disinfected by its alternate immersion and insolation. It would be almost impossible in most places habitually to beach large heavy boats capable of fishing in the open sea; the surf boats used for seining and cargo work are mere inshore vessels of light timbers sewn together, and are not adapted for fishing. On the West Coast where for 8 or 9 months the sea is calm, the dug-out canoe provides a fairly useful boat, which, with care, lasts for many years, but is in no sense anything but a fair weather boat.

Again, these boats, tackle, and methods have not been ill-suited to past economic conditions; in the absence of good roads and rapid communications, catches of fish much larger than could supply the wants

* Read at the Lahore Industrial Conference, 1909.

of the sea borders, were almost useless ; climate forbade deep-sea voyages for loads of fish which would taint before reaching shore and catches which could not attain a market ; ignorance of good curing methods prevented surplus catches from being properly dealt with ; while cheap boats and cheap methods suited the poverty alike of producer and market. It is probable also that with foods such as the millets, of a monotonous and insipid character, the highly flavoured products of the crude curing methods alone known, were positively acceptable or, at least, had grown so, to the poorer classes, just as the ngapi of Burma is a necessary article of diet to supplement the cereal ration, or as tainted fish of the "Madura cure" is demanded by certain sections of the Madras people.

But with modern conditions have come modern ideas and necessities ; public hygiene demands for the individual and for the community alike and in the common interests of both, that food should be of the best and safest quality obtainable, and should at least be above the suspicion of favouring, if not begetting, disease ; increasing wealth among many sections develops a more fastidious taste in food and a craving for new flavours and foods together with the ability to pay for them ; a population rapidly becoming dense demands more food and more nutrient food ; the fields demand more nourishment if they are to respond to the heavier demands for crops ; the industry and its workers need organization and capital to meet growing necessities.

The first public recognition of the necessity for development of the fisheries was in the mission of Dr. Day in 1869—71 who reported both on the marine and inland fisheries of the whole of India. For various reasons this report was not followed by organized, practical action—save in one very important matter—either on the part of Government or of the people; the time was not ripe for devising for the distant and vague harvest of the sea what was barely coming into contemplation for the harvest of the soil under foot ; for doing for the scattered, slender line of fisherfolk what was not yet being done for the more exigent and ever-present ryot. The one great exception was the grant of duty-free salt for curing fish within fenced enclosures, a reform initially due to the report and to the subsequent papers of Dr. Day, to whom

much honour is owing for his advocacy of this industrial concession.

Dr. Day's suggestions were accepted by the Madras Government, and from 1882 a gradually increasing number of yards, or bonded enclosures, were opened, at which salt is issued not only free of duty but often at rates much below the local cost of the salt to Government. In South Canara the charge per Indian maund (82 lb.) is As. 6–8, or 15 shillings per ton, a price which includes the whole cost of transport from the very distant salt pans of Bombay, Madras or Tuticorin ; in other districts the inclusive cost is 10 annas or £1-2-6 per ton, the practical result is that the total price charged by Government is often less than the mere transport charge, in which case the concession is an actual bounty. Government take no direct part in the curing ; the only conditions are that the fish shall be brought into the yard, salted and dried within its limits, and kept there till presumed fit for issue : the proportion of salt issued is governed by rules which have had the sanction of many years. There are 143 such yards scattered along the coast in which something over 50,000 tons of wet dressed fish are annually cured, the bulk of the yards and by far the greater bulk of the fish cured, being on the comparatively short line of the West Coast which is far more prolific than the eastern.

The result of this concession to the industry has not been all that was expected by Dr. Day, for the cure has not developed in quality, or even in quantity, proportionately to the cheapness of salt; the East Coast cure remains precisely what it was in Dr. Day's time and long before him or before a salt duty was charged, viz., an article often *very badly tainted*, the reasons being that the market seems to prefer or at least to be reconciled to a highly flavoured product which the curers can produce in their ancient way and with the minimum of care and charge, while, as will presently be seen, the mere cheapness of salt cannot counteract the results as to taint of long-standing primitive and defective customs in catching and marketing. The product of the West Coast is, in general, far better, partly because of the ease with which fish is caught close to the coast, partly because of the comparative abundance of fish so that much is taken direct to the curing yards, partly because of the immense

export to Ceylon which will not admit a really bad product; hence greater facility and care in the cure. Yet even on this coast a great deal is badly cured, especially that intended for the markets of the interior and particularly of the eastern tracts. It is obvious that to secure a generally good product the consumer must be educated as well as the producer, and the first step is the production, by various reforms, of a better article which will appeal first to the better class of consumer and will gradually become acceptable and available to others.

So matters remained for some years, till, early in 1905, the Government of Madras——*consule* Lord Ampthill ——took up the question of the marine and inland fisheries; their objects may be briefly summed up in the words "Better food, more food, more and better fertiliser, better organization." As regards marine fisheries, a brief explanation of these general expressions and of the methods now under experiment for the attainment of these objects will be of interest; the matter of inland fisheries must await another paper.

Better food.—This desideratum is placed prior even to the second item because, in the case of fish, quality must be sought before mere quantity; we must make the best use of what we now catch before proceeding to catch yet larger masses. Of all general foods, fish is most liable to taint and most poisonous when tainted, and to increase the amount of the catches under present conditions would be to increase the amount of dangerous food. While we need not, at present, accept Dr. Hutchinson's proposition that leprosy is generated by a diet of tainted or badly cured fish, it is *a priori* probable, and the probability is supported by convincing evidence, by expert medical opinion, and by the general practice and experience of other countries, that such food is productive of, or predisposes to, intestinal and other diseases. Tainted fish as produced in this country are not merely penetrated by masses of the putrefactive bacteria and by the very poisonous results of their activity, but are liable, often in a high degree, to contain —largely through the agency of flies—the germs which cause specific diseases such as cholera, typhoid, etc., especially where the fish are stored in the huts of fishing hamlets which have been the scenes of out-breaks of such diseases, or where fish-curing yards adjoin such

hamlets; recent cases, known to the writer, are in point. Apart, however, from this latter danger, the consumption of tainted fish is fraught with hazard, even to individuals or races which are accustomed to it, for the toxic products (ptomaines and toxins) of the putrefactive bacteria are not only produced most rapidly and abundantly in fish but appear to be abnormally dangerous, while even the best of cooking will not destroy some of them. Moreover the dangers arise at a very early stage of decomposition as when fish is soft or pasty, and before the sense of smell gives the danger signal; fish is unsafe at a stage when flesh meat seems to be innocuous.

Now the fish supply of the Presidency outside of the comparatively high class markets of Madras City, of the fishing centres themselves, and of a few places scantily served by fish in ice (and only then as regards those who can pay the price) is in a very great degree tainted; little is beyond suspicion, the grand cause being the tropical temperature which is precisely that at which putrefactive bacteria are most active and consequently taint most rapid.

The boats afford insufficient protection to the fish when caught, and the bulk of these are caught in the day time; the customs of the fishermen and the demands of the immediate fresh-fish market *forbid* the gutting and cleaning of the fish at sea so that the most putrescible portions remain for several hours within the fish; there is no such thing in existence as a live car or contrivance for keeping the fish alive up to the shore; the fish are often hawked about on the beach for local sale before being sent out to the outlying villages, where they mostly arrive in a high state of taint if the distance exceeds 5 miles, or to the curing yards; the methods, vessels, locale, and entourage at many curing centres are primitive and faulty. Hence abundant cause, wholly remediable, however, by degrees, for tainted fish whether fresh or cured.

There is however another cause, viz., the demands of the market. On the West Coast, as mentioned above, the bulk of the best cured fish is sent to Ceylon where the regulations forbid the entry of bad fish; hence the production of a salted and dried article which is far less faulty than that supplied to inland markets, and is in

many cases quite tolerable, especially where, as at Tellicherry, etc., the fish is caught solely on account of the curers, to whom it is at once taken. But the inland market appears to demand or easily accept fish in high and even putrid condition; the product known as "Madura cured" is practically putrid, and the bales on the railway stations, the carts on the sea coast roads, eloquently testify to the character of the products. As in other tropical countries it seems that a monotonous diet of millets and common vegetables demands a strongly tasting accompaniment, and this is supplied by stuff which, as frequently seen on the East Coast, is often fit, in European and the better class of Indian opinion, only for the manure pit. Nevertheless the demand continues, and while no one may dispute tastes, yet it is desirable so to educate the market on the one side and to supply tasty but sound products on the other, as to remove hygienically faulty products from the markets; in municipalities the Sanitary Inspectors are believed to condemn this class of goods. Moreover it is certain that a better quality of product would greatly increase the demand and consequently the catches; while tainted fish may be approved by certain classes, those more well-to-do and better educated decline such goods, and millions are consequently deprived of a nutritious food which they would readily buy if a thoroughly sound, pleasant article were supplied.

It would seem, in fact, that while better and equally cheap food for the masses is the main final object of work, it may be more easy to move indirectly, viz., by issuing from improved yards goods produced by the ordinary methods, e.g., salting and sun drying, but improved by scientific and technical knowledge and slightly more costly than at present, as well as goods prepared by new methods. These improved goods at slightly enhanced prices will appeal to numerous classes at present unable to accept existing products, and this demand will, in turn, foster an improved supply, so that better methods and a greater business will insensibly develop, as on the West Coast under the demand from Ceylon, and more capital will flow into the industry, to the benefit alike of producer and consumer. If the present low class goods are produced and sold at 1 to 2 annas per pound, it may be better to produce and sell

better but similar goods at 2 to 3 annas to a better class and an almost unlimited market, for the profits will attract both capital and a better class of producer as well as develop a demand for more raw produce and at better prices. Hence the problems both of better and of more food will tend to a ready and profitable solution.

Hence effort is now being directed in the experimental stations started by the Madras Government to various obvious and simple reforms. Firstly, to the introduction of live cars and live chests, or pens, so that fish can be brought alive to shore and kept in good condition till required; this was a universal custom even in temperate climates till the introduction of cheap ice, and still is in many cases. At the experimental stations the method is being tested and, when success follows, will doubtless become popular. Secondly, fish not kept alive *must be cleaned and washed at sea* and properly stowed; this brings them to shore with a much decreased chance of taint even if several hours intervene, while the time now occupied in gutting them on shore will be saved; this is now a successfully accomplished fact. Thirdly, fish intended to be eaten fresh must not only be brought alive, or properly cleaned, to shore but so treated subsequently that freshness will be preserved for a longer time than usual; experiments in this line have already been successful. Fourthly, the fish must be taken *at once* to the curing yard where cleanliness must be, as elsewhere, an *absolute rule*; clean receptacles, clean salt, clean drying grounds and tables (scaffolds or flakes); amongst other advantages it is found that fish, untained to start with and cured in absolute cleanliness, require less salt than in ordinary yards. Fifthly, rapidity of operation is in many cases necessary, so that fish brought in the early morning may be salted, dried (and smoked), by the evening; this has frequently been accomplished already and the product will keep perfectly good for some days. Sixthly, the production of really good products of ordinary and popular character even if at slightly enhanced prices, is a primary object, while nevertheless demonstrating principles and processes common to all proper curing which shall be applicable by the poorest curers to the cheapest goods. Seventhly, wholly new methods which will yield an absolutely wholesome yet tasty product, fit for universal consumption

are necessary and available; salted and dried fish can be supplied free from all taint, smoked fish is already in demand and this cure has been undertaken by several private firms and persons; pickled fish is now under trial, while canning for which experimental plant has been obtained, is a necessity and a certainty of the immediate future. These methods and many other possibilities too numerous to mention, will largely cure the evil of tainted fish supplies, and are already in active, if experimental, progress. But only a beginning has been made, and many years of thought, experiment, and demonstration are yet necessary before untainted food will be supplied from all our fishing and curing centres.

More food.—This is not so simple a development as may be thought. Moreover there are two branches of the subject; the first is the turning into food of much of the present catches which is not so utilized; secondly the catching of more fish. *Firstly*, along the West Coast and in parts of the East Coast certain fish appear at times in enormous shoals and are caught in such quantity that, with the appliances and methods now in use, they cannot be treated as food but are dried on the sand and become a rude fertilizer, most of which is exported to foreign countries at low prices. A single recent day's work at one fishing centre produced 110 tons of fresh fish, chiefly mackerel; single hauls of a shore seine frequently exceed several tons of sardine. There is no more wasteful or unprofitable way of treating such fish than drying them for fertilizer on the sand; as food they would directly maintain their tens of thousands. When these sardine masses are cured as food, the present method is to clean as many as possible, salt, and dry them in the usual way; these are fairly good, but those which cannot, for lack of time and space, be so dealt with, are strewn on leaf mats in the sun and dried without cleaning or salt, the result of which—*experto credite*—is food, but food of which most should be condemned. Again, in parts of the Presidency, scaleless fish or animals are not eaten, so that sharks and dog-fish, skates and rays, porpoises, etc., though caught are not properly utilized as they are on the West Coast; the flesh of these should be so utilized that less particular folk may be nourished.

It is obvious that the introduction of new methods, enterprise, and capital into the industry will utilize these masses of fish as edible food ; the keeping of quantities of fish—sardines, mackerel, etc., are all caught alive—in live chests or pounds till needed, refrigeration, the use of innocuous preservatives, etc., will enable curers gradually and safely to turn larger quantities of fish into good food ; the method of salting down pilchards in masses, after the Cornish fashion, will equally suit sardines ; speedier processes and larger plant will deal in equal times with larger quantities ; the introduction of canning on a considerable scale and in large cans, as in Japan, will provide most wholesome food for use even by the masses. All these methods except refrigeration are now under actual experiment, and will be available for public demonstration shortly if not already on view.* The limits of this paper prevent further elaboration of this point.

Secondly, more fish should be caught ; the present difficulty of dealing with unwieldy occasional catches is greater than that of disposing of larger ordinary catches, if they can be regularly obtained. The questions here are whether fish are of sufficient general abundance to admit of much larger catches, and, if so, the best method of taking them. As mentioned above, the fishing fleets of the Presidency consist, in general, of catamarans (rafts) and dug-out canoes or similar small open boats ; hence the fishing is, in general, confined to a narrow and shallow inshore belt of perhaps 6 miles wide and up to 8 fathoms in depth according to locality and season. Within this belt there is a great deal of immemorially ancient fishing with numerous boats, canoes, and apparatus from the villages which line the coast, and it is probable that, except for attacks upon shoals, no great development of capturing methods is desirable or permissible inside that area ; the appearance of steamers and other powerful vessels would be prejudicial not only to the vested fishing interests of a large fishing population, but probably to the supply of fish ; restrictive regulations should certainly precede such up-to-date attempts at development. For attacks upon shoals some

* The Government cannery is in successful operation, and refrigerating plant has been obtained and will shortly be at work.

license is permissible ; probably these vast bodies of fish are as inexhaustible as the herring shoals of the British and other coasts, and it is evidentially certain that vast shoals frequently pass untouched, because unperceived, a few miles out at sea ; it is even true that fishermen sometimes deliberately neglect to make possible catches because present appliances and methods do not admit of dealing with them, a strong argument for the rapid development of curing enterprise. But with regard to deep-sea fishing, i.e., beyond the 6 mile limit, there need be no restriction and there should be development, the obvious method being the use of larger boats using more powerful nets and lines, able to keep the sea comfortably for a week together so as to avoid the vast loss of time in daily voyages, and carrying salt, under the existing Madras rules for the carriage of duty-free salt, for curing their fish on board, as on the coasts of the United States, Holland, etc.

Now private enterprise necessarily feels diffident in deep-sea developments ; the fisherfolk are poor and ignorant, and there is no class corresponding to the fishery capitalists who finance and organize the vast fishing industries of Great Britain ; it is not certain that deep-sea fishing will pay ; it is not clear whether the fish are there in such abundance and frequency and accessibility that large boats would pay their expenses, nor is there any one who will risk the cost of building large boats on a speculative enterprise. Hence it has been left for Government to attempt the enterprise, and two boats are now being built—one a motor boat—to test this question. Though large as compared with existing craft, they are really small, viz., 14 and 22 tons, but they will suffice to settle the question and are big enough for all present ordinary purposes in these waters. Moreover, the use by the Cannanore Experimental Station of two Ratnagiri (Bombay) boats, of about 8 tons each, in these Malabar waters, shows that they can catch, somewhat further out to sea than the canoes, large fish (seer, etc.) in quantities and of a character quite impossible to canoes ; using large and long drift nets they bring in very paying loads of valuable fish. Later in the season these boats go still further to sea, remaining out for a week, and catch shark, etc., in abundance, salting their catches on board ; hitherto they have used duty-paid salt which,

being costly, was used in greatly insufficient quantity ; they will now use duty-free salt under the Madras rules above mentioned. Boats such as these and work such as they do, appear to show that deep-sea fishing will pay sailing boats,—possibly with auxiliary motor-power—very well, and a season or two should entirely settle this question ; if the answer is in the affirmative, a large field for increasing the regular supply of fish will be opened out. It is doubtful, however, if, at present prices, steam can possibly pay ; in these Madras waters trawling is out of the question and steam drifting and lining of uncertain success. In any case the natural primary development from the catamaran and canoes is to the small sailing smack, with perhaps auxiliary motor-power and motor carriers to save time when fish must be brought fresh to shore ; from catamaran to steam trawler would, *in Madras waters*, be a leap economically unnatural and commercially hazardous.

A method of increasing the food supply is by pisciculture, but for the present this, with one exception, can only be carried out in inland (fresh) waters. The exception is that of the culture of shell-fish, such as oysters and mussels, as so widely carried out in western countries and Japan ; being non-migratory these animals yield the largest returns to careful culture ; where the oyster is laid there he stays and grows. These shell-fish are very abundant and prolific in India, the backwaters teeming with them, and growing them at rates unexampled outside of the tropics. The edible oyster is found of good quality in most of the backwaters and can be obtained at nominal rates since it is eaten by Indians only to a small extent ; the water at the spawning season is full of spat, and the simplest of means will ensure abundant crops ; mussels of huge size and clams are also found in great abundance. It has been found by experiment at Ennore that the oyster spawns in the backwater on the stimulus provided by the inrush of fresh water in the rainy season (there the north-east monsoon), and tile collectors put down in October 1908 in a somewhat unfavourable corner of the lagoon, were found covered with spat in the middle of December of the same year, with the astonishing additional fact that some of the young oysters had attained the diameter of $1\frac{3}{4}$ inches in a maximum period of ten weeks, a rate of

growth absolutely phenomenal when compared with that even of France; a second experiment in the current year has confirmed the previous one. Mussels of eight inches in length are also common and the clam is so abundant as to provide a large lime-burning industry with shell.

Though the oyster and mussel are not greatly utilised as food in India there is a wide opening for a preserving industry; shelled and iced they would be in large demand amongst Europeans in India; shelled and dried there is an inexhaustible market in China; properly canned they would be taken in large quantities in western countries and by Europeans in India; reduced to extract—with or without the meat—by proper processes, they form a highly nourishing and digestible food specially recommended for invalids; mussels and clams are, in America, made into extract which is considered superior even to that from oysters.

Before these steps can be taken it is necessary to survey our best beds, to consider the methods and restrictions necessary for promoting their development, and culture, to test the methods by experiment, and then to publish the details; the Ennore experiment is only a first and slight step in this direction. Restrictions are obviously necessary. Great Britain, America, France, Holland have all ascertained this necessity, and in India we have as a first warning the practical, if temporary, destruction, or at least depletion, of the well-known Karachi oyster beds which formerly supplied excellent oysters in ice at cheap rates to up-country consumers, but which have been depleted by wasteful methods and by the total absence of culture; these mistakes must be avoided.

More and better by-products.—This paper can only touch and that briefly, on two such products, viz., sardine oil and fertilizer. As mentioned above, sardine reach the West Coast (and northern parts of the East Coast) in shoals vast but of very irregular periodicity, from June to March; during the south-west monsoon they are practically protected by the weather, which is fortunate since they are then spawning, but from October to March they are fat and easily attacked. These fish produce abundance of fish oil, while the "scrap" after the expression of the oil is a first class fish guano and should contain about 8 per cent. of nitrogen, and a nearly

similar amount of phosphoric acid. The oil obtained by ancient methods, viz., by the putrefaction of masses of fish in open receptacles, was a product of disgusting character and its production has largely fallen off, owing mainly to the introduction of mineral oil and to its own unpleasantness. At present the masses of fish which, for want of time or means, cannot be turned into food, are, in general, simply dried on the open sand of the beach; the viscid oil takes up an immense amount of sand, and the whole product when dry is then sent to the coffee estates of the interior or Ceylon, etc., as manure. Hence the consumer obtains a product by no means suitable to his real wants; the oil, useful elsewhere, is not only useless as a fertilizer but is objectionable, clogging the soil and delaying decomposition; some of the nitrogen has been lost by partial putrefaction, while the sand is obviously a mere nuisance. Consequently the producer obtains a very low price, since the consumer has to buy and pay carriage on inert or undesirable matter; neither party is pleased. It is absurd that the fisherman should get only from Rs. 18 to 24, averaging about Rs. 20, for a ton of dried sardine. Now while it is obvious that these valuable substances should be so treated as to insure the obtaining of their full value, the attainment of this object is not easy. There is considerable difficulty in dealing with them on the large scale in *central* factories; the shoals are most irregular in appearance often at long intervals, and though they are probably not far off, it is difficult, with present appliances, to find them; if the factory deals with dried sardine the sand adulterant is a very serious if not fatal stumbling block and the products are, in any case, less satisfactory than if fresh fish are used; if with fresh sardine, then regular supplies can only be obtained, and not even then with certainty, by the use of power-driven boats scouring the coasts for catches, in which case the cost may outweigh the value of the products. Hence it would seem more economical, industrially, to have a chain of very small factories, as formerly on the American coasts, which, with plant costing at most only a few hundreds of rupees each, will deal with the sardine wherever and whenever it arrives, and can remain idle without serious loss; moreover by exercising care and direct supervision locally in drying the fish free from sand, a small factory

can continue work on dried fish when fresh fish is not available. The plant required is nothing but one or more open boiling pans, one or more wooden presses, a filter, and a supply of tubs; with this chief plant *can* be turned out oil and fertilizer of good quality, which could then be sold to brokers who would blend the products and place them with a guarantee of quality or analysis on the markets; the oil for various purposes such as the batching of jute, the fertilizer to the hungry fields of India. These petty factories can either be started singly as individual ventures, or in groups by the help and under the control of small firms or capitalists who will obtain their profits as the brokers or middlemen. This method was advocated in public papers about $1\frac{1}{4}$ years ago; up to date one enterprising Indian merchant has adopted it as a personal venture, and has now three screw presses and boilers; developments, in the way of promoting a number of such petty works, are under discussion by others. A similar plant intended to demonstrate improvements in the saving of labour, rapidity, the quality of the oil and guano, the preservation of the fresh fish from taint pending operations, etc., has been started by the Government Experimental Station, and good results are expected.* There is a wide opening for proper dealing with such fish as, *at present*, cannot be turned into food; the final object however should be to increase the food supply at the expense of the yield in fertilizer, for the direct nourishment of the people by the consumption of the fish itself is a more economical use of fish than its transformation into fertilizer, which, indeed, should mainly reach the soil *indirectly* after doing its work as food.

But there is a wholly untouched, unobjectionable, and permanent supply of fish manure in "fish waste"; the "utilisation of waste" is one of the reforms which India has to learn from Japan; that which at present is a sanitary nuisance, whether night soil or fish waste, may become a vast source of wealth. Fish waste consists of the offal or guts of the masses of fish brought to shore; of quantities of fish too putrid for use as food; of fish-bones, heads, and other residues; all these are now badly wasted, only a small portion of the offal being used as

* By 1914 211 small private factories, extending in a chain along the coasts of Malabar and South Canara, were in active operation.

manure. While it is impossible for a large factory to deal with the stuff which is scattered in small quantities along the coast, it is easy for individuals at each locality to collect it and to utilize it by simple methods now under demonstration. To bury a ton or two of tainted sardines in the porous sand of the beach and dig up what remains some months later, is an error in management ; to throw the offal into the sea or leave it on the beach, to bury the skeletons of sharks and skates in the sand and never to dig them up at all, is pure waste. In Japan every ounce of offal, residues, bones, etc., is gathered and added to the compost heap, and this valuable stuff is equally needed here. In America it was recently calculated that the refuse, exclusive of the bones otherwise thrown away, amounts to 112,500 tons annually at an average of 25 per cent. on the catches ; if this be taken even to include bones, it means that on this Madras West Coast not less than 15,000 tons are annually wasted, irrespective of tainted fish which are common in this climate. This method of utilizing waste is being specially dealt with at the Cannanore Experimental Station.

Better Organization.—It is obvious that in developing the fishing industry for the benefit of the consumer, an essential consideration is the producer ; not merely does the development ultimately rest with him but his welfare is, *pro tanto*, as important as that of the consumer. For it is no new industry to be introduced *ab extra*, but the development of an ancient and indigenous one, employing a vast number of people who have immemorial interests and customs, who form no negligible portion of the population, and who ought to develop *pari passu* with the industry, in status, in intelligence, in independence, and in wealth. The matter is one of extreme difficulty, for while more or less loosely bound in ties of caste or religion—for Hindus, Christians, and Mahomedans are all found in very large numbers—they are far less united in corporate life than the inhabitants of an inland village, with their village administration, defined boundaries, rights and privileges, their corporate sentiment and communal and agricultural ties ; while, taking them, *en masse*, especially on the East Coast, they are far more ignorant and poor and in many cases, less diligent and thrifty, than the cultivator of the soil. Hence if it be difficult to introduce new methods in the villages, it is

yet more difficult to develop the fisher folk by means which shall make and keep them independent yet co-operative, and to prevent their degeneration into mere labourers still more at the disposal of richer folk than they are now.

But it is impossible to deal with so vast a question, which is largely administrative and not merely industrial, at the end of a paper already too long. The subject is having attention alongside of the technical ones, and, as might be expected, attempts will be made to develop co-operation side by side with a certain amount of Government assistance, whether by loans after the fashion of agricultural loans, by technical and general education, and by such other means as may arise in practice. There is one advantage which we possess over similar efforts in agriculture, viz., that the demonstration of improvement is easier ; just as the ryot was instant in his recognition of the superiority of the iron sugar-mill over the ancient wooden one (which has disappeared within the period of the writer's service) owing to the fact that it yields, in the more rapid and abundant flow of juice, a tangible and measurable improvement, so the larger boat, the more powerful net, the larger catches, the more valuable and better-keeping product, will probably appeal at once to the fisherman ; there are, in fact, recent examples of his adopting new nets and long lines on this coast, while several have accepted modern improvements in curing. Hence it may be possible for experts to educate the fisherman in new technical methods more easily than the agriculturist. Hence, again, the necessity for taking care that the improvements introduced, whether in catching or in curing, are, as far as possible, so simple, so cheap, so obvious, so suited both to producer and consumer, as to commend themselves at sight to adoption by persons of limited mental and economic capacity ; to neglect the step-by-step method would be an economic and social error, since the aim should be to foster the independent yet co-operative owner of the fishing smack and the petty factory rather than the capitalist-cum-labourer.

In many cases, moreover, capital will find its easiest and safest outlay in the encouragement of small folk in small ways ; where an industry is obliged to operate over a very long line of coast but on a very narrow sea belt,

with no special harbours or railway facilities, with a wholly unorganized and very low priced market in the interior, with uncertain and perhaps merely short-season harvests, and in a tropical climate where taint is immediate and ice unattainable or costly, the central capitalist factory positively invites loss if, except perhaps at one or two localities, it invests heavily in plant. The cost of running a steam fleet, the uncertainty of its catches especially when restricted from interference with the habitual inshore fishing grounds of the ordinary folk, the inability to dispose of such catches except at its own factory, and many other reasons, rule out, for the present, anything except localized effort as displayed in better sailing boats plus small motors ; the wholly British idea which has actually been promulgated in this Presidency, of a steam fleet seeking out fish anywhere in the deep-sea and delivering catches at any port where it might find itself, is ludicrous in the absence of an organized market, trade, and communications. Hence the fostering of local effort and small plant, the supervision of their methods, and the purchase of their goods, is a more hopeful and possible plan. Similarly in the fish-oil and fertilizer trade, the difficulties in dealing with the fish at a central factory are immense, and, as already argued above, the more advisable plan is one which is consistent with the development of the small folk, viz., the fostering of a chain of petty works by small folk.

To sum up ; we have in this Madras Presidency an ancient industry employing a large population but primitive in its methods from catch to sale ; knowledge and capital, energy and organization, introduced as much as possible by private enterprise, are necessary to improve the old and develop new methods in such wise as to ensure that the present catches shall all be turned into wholesome food ; that these catches shall be gradually augmented, as the fisher folk show capacity to deal with them, so as to assist in feeding a growing population ; that fish which for any good reason cannot be turned into direct food shall, after the expression of their oil, be turned into high class fertilizer for the benefit of *Indian* soil ; that fish waste shall be utilized to the utmost possible extent ; and that these developments shall be carried out as far as possible through and for the benefit of the existing fisher folk and curers, and by means, on

the Government side, of a carefully devised general and technical education—and other assistance—in which demonstration through experimental stations, fixed and peripatetic, shall play a chief part. Such are the main items of the direct programme for the Madras Presidency. Be it remembered that if we take the present annual catches in this Presidency roughly as 150,000 tons of edible fish, this is but one-seventh of the British catches for a similar population; that the addition of only 100,000 tons would mean additional edible rations of something like 180 million pounds, or nearly 4.5 lb. per head for every man, woman, and child in the Presidency, an appreciable addition to the food of the meat-eating population, while there would also be 20,000 tons of offal, etc., for conversion into manure; the whole of this mass of food and fertilizer would be pure gain to the country and especially to the working classes, while various by-industries, which there has been no space to discuss, would accompany the development; such industries are those which relate to boat building, machinery, the pressing and refining of edible vegetable oils, the production of vinegar, pottery, refrigeration, co-opering, pearl button making, tin plate working, etc., to say nothing of increased traffic and business dealings. Briefly, the goal aimed at is the development of a vast existing industry with its concomitant by-industries in such way as to stimulate and develop, enrich and wholesomely feed, the greatest possible number of people in the desirable process of adding the harvest of the sea to the harvest of the soil.

A LIST OF TAMIL NAMES OF THE FISH OF THE MADRAS PRESIDENCY.

Transliteration.	Tamil name.	Scientific name.
Ādātirukkai	ஆடாதிருக்கை	Trygon sephen.
Adukkuppalsurā	அடுக்குப்பல்சுறா	Carcharias ellioti.
Akāmpārai	ஆகாம்பாறை	Chorinemus moadetta.
Ākkanānkeliru	ஆக்கணாங்கெளிறு	Plotosus canius.
Ākkelutti	ஆக்கெளுத்தி	(1) Plotosus canius. (2) P. arab.
Allātti	அள்ளாத்தி	Elops saurus.
Ambattankatti	அம்பட்டன்கத்தி	Mene maculata.
Ambattanpārai	அம்பட்டன்பாறை	Mene maculata.
Ambattanvālai	அம்பட்டன்வாளை	Notopterus kapirat.
Ānaivāyankattalai	ஆனைவாயன்கத்தலை	(1) Umbrina macroptera. (2) Sciæna vogleri.
Appe	அப்பெ	Monacanthus monoceros.
Āral	ஆரல்	Rhynchobdella aculeata.
Āranisurā	ஆரணிசுறா	Scyllium marmoratum.
Ārrukendai	ஆற்றுக்கெண்டை	Barillius gatensis.
Asarai	அசறை	Lepidocephalichthys thermalis.
Attavannaitirukkai	அட்டவண்ணைதிருக்கை.	Pteroplatea micrura.
Attukkattikola	ஆத்துக்கட்டிக்கோலா.	Belone strongylura.
Attuvālantirukkai	ஆட்டுவாளன்திருக்கை.	Trygon sephen.
Ayarai	அயறை	Lepidocephalichthys thermalis.
Ayinkavalai	அயிங்கவலை	Clupea fimbriata.
Chadakkan	சடக்கன்	(1) Platax teira. (2) P. vespertilio. (3) Heniochus macrolepidotus.
Chānippārai	சாணிப்பாறை	Gazza argentaria.
Chankumūnjikaravā	சங்குமூஞ்சிகரவா	Upeneus luteus.
Chāvālai	சாவாளை	Trichiurus haumela.
Chellākkāsu	செல்லாக்காசு	Etroplus maculatus.
Chellal	செல்லல்	Etroplus maculatus.
Chengan	செங்கண்	Cirrhitichthys aureus.
Chengarā	செங்கரா	Synagris japonicus.

Transliteration.	Tamil name.	Scientific name.
Chettai	செத்தை	Pimelepterus cinerascens.
Chilpi	சில்பி	Holacanthus imperator.
Chinnatumbi	சின்னதும்பி	Pegasus draconis.
Chippili	சிப்பிலி	Scatophagus argus.
Chottaiporuvā	சொட்டைப்பொருவா.	Engraulis telará.
Emankōlā	யேமங்கோலா	(1) Histiophorus immaculatus. (2) H. brevirostris.
Ērivālai	யேரிவாளை	Wallago attu.
Erumainākku	எருமைநாக்கு	Psettodes erumei.
Īkkarakōlā	ஈக்கறகோலா	Chorinemus toloo.
Ilippāmbu	இலிப்பாம்பு	Ophichthys erientalis.
Illipā	இல்லிபா.	Pristis zysron.
Kadalkudirai	கடல்குதிரை	(1) Synganathus serratus. (2) Hippocampus guttulatus.
Kadalvirāl	கடல்விருல்	Elacate nigra.
Kadichai	கடிச்சை	Pristipoma maculatum.
Kākkāchi	காக்காச்சி	(1) Ambassis commersoni. (2) Myripristis murdjan.
Kālā	காலா	Polynemus spp.
Kalikkāral	களிக்காறல்	Equula splendens.
Kalkkākāchi	கல்காகாச்சி	Holocentrum rubrum.
Kalkāsā	சல்காசா	Holacanthus xanthurus.
Kallappārai	கள்ளப்பாறை	(1) Caranx kalla. (2) C. armatus.
Kallitirukkai	கள்ளிதிருக்கை	Urogymnus asperimus.
Kallukōzhimin	கல்லுகோழிமீன்	Holacanthus imperator.
Kalmadanam	கல்மதனம்	Scolopsis vosmeri.
Kalmin	கல்மீன்	Lutjanus marginatus.
Kalnavarai	கல்நவரை	Upeneus indicus.
Kalpāmbu	கல்பாம்பு	Synganathus serratus.
Kalpelāchi	கல்பெலாச்சி	(1) Minous monodactylus. (2) Ostracion turritus.
Kalūdān	கல்ஊடான்	Gerres oblongus.
Kaluluvai	கல்உளுவை	Percis punctata.
Kānānkalutti	கானாங்களுத்தி	(1) Scomber microlepidotus. (2) S. brachysoma.
Kandal	கண்டல்	Synagris tolu.

Transliteration.	Tamil name.	Scientific name.
Kanjākelutti	கஞ்சாகெளுத்தி	Plotosus arab.
Kannippārai	கன்னிப்பாறை	Caranx atropus.
Kāraikkutti	காரைக்குட்டி	Scolopsis vosmeri.
Kāral	காறல்	Equula fasciata.
Karandippārai	கறண்டிப்பாறை	Caranx jarra.
Karappārai	கறப்பாறை	Caranx sansun.
Karavā	கறவா	Upeneus cinnabarinus.
Kārikattālai	காரிகத்தாளை	Sciæna diacanthus.
Karimūnjippārai	கரிமூஞ்சிப்பாறை	Caranx ire.
Karimuttaisurā	கரிமுட்டைசுறு	(1) Carcharias menisorrah. (2) C. dussumieri.
Karivālai	கரிவாளை	Chirocentrus dorab.
Karivālankōlā	கரிவாளங்கோலா	(1) Belone melanostigma. (2) B. choram.
Kārruppettai	காற்றுப்பேத்தை	Tetrodon immaculatus.
Kārtikavālai	கார்த்திகவாளை	Trichiurus savala.
Karukkāpārai	கருக்காபாறை	Caranx sansun.
Karumanikkendai	கருமணிக்கெண்டை	Labeo kontius.
Karumpelāchi	கரும்பெலாச்சி	Tetrodon margaritatus.
Karunachuzhi	கருநச்சுழி.	Gobius gymnocephalus.
Karunkattalai	கருங்கத்தலை	(1) Umbrina dussumieri. (2) Sciæna albida.
Karunkelutti	கருங்கெளுத்தி	Arius nella.
Karuntumbi	கருந்தும்பி	(1) Pterois miles. (2) Gymnapistus niger.
Karuppumattivāyan	கருப்புமட்டிவாயன்	Chrysophrys berda.
Karuppuvauvāl	கருப்புவெளவால்	Stromateus niger.
Karuppuvirāl	கருப்புவிரால்	Ophiocephalus striatus.
Karuvātirukkai	கருவாதிருக்கை	Aetobatis narinari.
Kārvā	கார்வா	(1) Lethrinus miniatus. (2) L. karwa. (3) L. nebulosus. (4) Lutjanus malabaricus.
Kattā	கட்டா	Chorinemus sanctipetri.
Kattaikkelutti	கட்டைக்கெளுத்தி	Macrones cavasius.
Kattakkīchān	கட்டக்கீச்சான்	Therapon theraps.
Kattāzhai	கத்தாழை	Pristipoma dussumieri.
Kattāzhaikkendai	கத்தாழைக்கெண்டை	Sciæna coitor.
Kattikkālā	கட்டிக்காலா	Polynemus sextarius.
Kattitirukkai	கட்டிதிருக்கை	Trygon kuhli.
Kattuppiriyan	கட்டுப்பிரியன்	Lutjanus rivulatus.
Kavalai	கவலை	(1) Clupea atricauda (2) Dussumieria acuta.
Kazhikkāral	கழிக்காறல்	Equula splendens.
Kelutti	கெளுத்தி	Macrones seenghala.

Transliteration	Tamil name.	Scientific name.
Kīchān	கிச்சான்	Therapon puta.
Kilātti	கிளாத்தி	Triacanthus strigilifer.
Kilichal	கிளிச்சல்	Cæsio cuning.
Kilimīn	கிளிமீன்	Pseudoscarus chrysopoma.
Kilinjān	கிளிஞ்சான்	Pseudoscarus chrysopoma.
Kizhangān	கிழங்கான்	Sillago sihama.
Kōdakkuttuvā	கோடக்குத்துவா	(1) Pellona indica. (2) P. brachysoma.
Kodunkāral	கொடுங்காறல்	Equula insidiatrix.
Koduntalaiporuvā	கொடுந்தலைப்பொருவா.	Engraulis kammalensis.
Koduvā	கொடுவா	Latis calcarifer.
Kōlākkattā	கோலாக்கட்டா	Chorinemus toloo.
Kōlarinjān	கோல் அரிஞ்சான்	Labeo ariza.
Kōlāsurā	கோலாசுரு	Carcharias macloti.
Komārappārai	கொமாரப்பாறை	Caranx rottleri.
Kōmarāsisurā	கோமராசிசுரு	Stegostoma tigrinum.
Kombankelutti	கொம்பன்கெளுத்தி	Macrones aor.
Kombansurā	கொம்பன்சுரு	Zygæna blochii.
Kombantirukkai	கொம்பன்திருக்கை	Dicerobatis eregoodoo.
Komorinsura	கொமொரின்சுரு	Stegostoma tigrinum
Korangansurā	கொரங்சன்சுரு	(1) Stegostoma tigrinum. (2) Chiloscyllium indicum.
Koravai	கொரவை	Ophiocephalus punctatus.
Kōttāntirukkai	கோட்டான் திருக்கை	Dicerobatis eregoodoo.
Kōttukkāral	கோட்டுக்காறல்	(1) Equula blochii. (2) Gazza minuta.
Kottulu	கொட்டுளு	Ostracion cornutus.
Kōvaikīchān	கோவைகிச்சான்	Therapon puta.
Kōzhakelutti	கோழக்கெளுத்தி	Pangasius buchanani.
Kozhal	கொழல்	(1) Seriolichthys bipinnulatus. (2) Chanos salmoneus.
Kozhimīn	கோழிமீன்	Acanthurus gahm.
Kozhuttamural	கொழுத்தமுறல்	Hemirhamphus limbatus.
Kullārāl	குள்ள ஆரல்	(1) Rhynchobdella aculeata. (2) Mastacembelus armatus.
Kulumpārai	குளும்பாறை	Caranx gymnosteihoides.
Kūndal	கூந்தல்	Scolopsis vosmeri.
Kundalamuluvai	குண்டலம் உளுவை	Gobius striatus.
Kūri	கூறி	Chrysophrys berda.
Kurunkendai	குருங்கெண்டை	(1) Barbus chola. (2) B. dorsalis.
Kuruvā	குருவா	Sciæna maculata.
Kuruvipēttai	குருவிபேத்தை	Tetrodon immaculatus.
Kuruvittirukkai	குருவித்திருக்கை	Rhinoptera adspersa.
Kuttidi	குத்திடி	Trachynotus ovatus.

Transliteration.	Tamil name.	Scientific name.
Kuttuvā	குத்துவா	Pellona brachysoma.
Kūzhakkelutti	கூழக்கெளுத்தி	Pangarius buchanani.
Kuzhimīn	குழிமீன்	Muræncsox talabon.
Kuzhippāmbu	குழிப்பாம்பு	Muræncsox talabon.
Kuzhippannā	குழிப்பன்னு	(1) Sciæna aneus. (2) Otolithus maculatus. (3) O. ruber.
Madakili	மடக்கிளி	Therapon jarbua.
Madavai	மடவை	Mugil spp.
Madanam	மதனம்	(1) Diagramma crassispinum. (2) D. griseum.
Madukkendai	மதுக்கெண்டை	(1) Chatoessus chacunda. (2) C. nasus.
Manaltirukkai	மணல்திருக்கை	Trygon volga.
Mandaikāral	மண்டைகாறல்	Equula edentula.
Mandaikeliru	மண்டைக்கெளிரு	Arius thalassinus.
Mandinisurā	மந்தினிசுறு	Carcharias sorrah.
Manjakalava	மஞ்சகளவா	Serranus flavocæruleus.
Manjalkōzhimīn	மஞ்சள்கோழிமீன்	Chætodon octofasciatus.
Manjalpārai	மஞ்சள்பாரை	Caranx malabaricus.
Manni	மண்ணி	Ophiocephalus gachua.
Mānuluvai	மானுளுவை	Rhynchobatus ancylostomus.
Marānkendai	மருங்கெண்டை	Megalops cyprinoides.
Marittānkendai	மரித்தான்கெண்டை	Barilius bendelisis.
Mattachāvālai	மட்டசாவாளை	Trichiurus muticus.
Mattakombansurā	மட்டகொம்பன்சுறு	Zygæna tudes.
Mattasurā	மட்டசுறு	Carcharias gangeticus.
Mattatirukkai	மட்டத்திருக்கை	Rhinoptera adspersa.
Mattivāi	மட்டிவாய்	Scolopsis vosmeri.
Mattivāyan	மட்டிவாயன்	Chrysophrys datnia.
Māttupelāchi	மாட்டுபெலாச்சி	Ostracion cornutus.
Mattuvāyudakam	மட்டுவாய்ஊடகம்	(1) Gerres lucidus. (2) G. setifer.
Māvulāsi	மாவுலாசி	Cybium commersonii.
Mayarai	மயறை	Eleotris fusca.
Mayilmin	மயில்மீன்	Histiophorus gladius.
Mettampārai	மெத்தம்பாறை	Cæsio pinjalo.
Mettampiriyan	மெத்தம்பிரியன்	Lutjanus annularis.
Mōhān	மோகான்	Stromateus sinensis.
Mōna ārāl	மோன ஆரல்	Rhynchobdella aculeata.
Mosadi	மொசடி	Upeneus indicus.
Mosingipārai	மொசிங்கிபாறை	Caranx djedaba.
Mullanpelāchi	முள்ளன்பெலாச்சி	Tetrodon patoca.
Mullantirukkai	முள்ளன் திருக்கை	(1) Urogymnus asperrimus. (2) Halieutæa stellata.

Transliteration.	Tamil name.	Scientific name.
Mullāru	முள்ளாறு	Triacanthus strigilifer.
Mullupelāchi	முள்ளுபெலாச்சி	Diodon hystrix.
Mulluvālai	முள்ளுவாளை	Chirocentrus dorab.
Mundakkankākkāchi	முண்டக்கண்காக்காச்சி	(1) Myripristis botche. (2) Apogon glaga.
Mundaikannitirukkai	முண்டைகண்ணிதிருக்கை.	Rhinoptera adspersa.
Mundakkankaravā	முண்டக்கண்கறவா	Pempheris malabarica.
Musali	முசலி	Lobotes surinamensis.
Nachuli	நச்சுளி	Opisthognathus rosenbergii.
Nāikadichē	நாய்கடிச்சே	Lutjanus sebæ.
Nāikelutti	நாய்கெளுத்தி	Pseudotropius sykesii.
Nāimīn	நாய்மீன்	Pseudoscarus æruginosus.
Nakarai	நகரை	(1) Upeneoides sulphureus. (2) U. tragula.
Nallatarattai	நல்லதரட்டை	Ephippus orbis.
Nāmakkāral	நாமக்காரல்	Equula daura.
Nāmappārai	நாமப்பாரை	Caranx leptolepis.
Nannepārai	நண்ணெப்பாறை	Caranx ire.
Narayanantumbili	நாருயணன் தும்பிளி	Saurus myops.
Nāsuvankāral	நாசுவன்காறல்	Equula ruconius.
Nāyaralu	நாயறலு	Psettodes erumei.
Nedumānkelutti	நெடுமாங்கெளுத்தி	(1) Arius thalassinus. (2) A. parvapinnis.
Nedunākku	நெடுநாக்கு	Plagusia marmorata.
Neduvāliūdakam	நெடுவாலிஊடகம்	Gerres filamentosus.
Neivetti	நெய்வெட்டி	Periopthalmus koelreuteri.
Nelakorukkai	நெலகொறுக்கை	(1) Ichthyscopus inermis. (2) Antennarius nummifer.
Neliyansurā	நெளியன்சுரு	Carcharias laticaudus.
Nettili	நெத்திலி	Engraulis indicus.
Nūlēni	நூலேணி	Lutjanus lineolatus.
Nunalai	நுணலை	Clupea brachysoma.
Odadi	ஒதடி	Upeneus macronema.
Ōlaivālai	ஓலைவாளை	(1) Trichiurus haumela. (2) T. savala.
Olari	ஒளறி	Amblypharyfigodon melettina.
Orā	ஒரு	(1) Teuthis java. (2) T. vermiculata. (3) T. concatenata. (4) T. oramin.
Ottāmpārai	ஒட்டாம்பாறை	Caranx oblongus.

Transliteration.	Tamil name.	Scientific name.
Pachaikkutti	பச்சைக்குட்டி	(1) Chatoessus chacunda. (2) C. nasus.
Padangān Pāluluvai	படங்கான் பால் உளுவை	(1) Rhynchobatus djeddensis. (2) Rhinobatus granulatus. (3) R. halavi.
Pālsura	பால் சுறு	Mustelus manazc.
Pāmbankōlā	பாம்பன்கோலா	Belone annulata.
Panai	பனை	Polyacanthus cupanus.
Panaiēri	பனையேறி	Anabas scandens.
Panjalai	பஞ்சலை	(1) Barbus sarana. (2) B. chrysopoma.
Panjaditirukkai	பஞ்சாடி திருக்கை	Myliobatis maculata.
Pānjālantirukkai	பாஞ்சாலன் திருக்கை	Trygon kuhlii.
Panjukkalavāi	பஞ்சுக்கலவாய்	(1) Serranus gilberti. (2) S. undulosus.
Pannā	பன்னு	(1) Sciæna aneus. (2) Polyacanthus cupanus.
Pannikkalavāyan	பன்னிக்கலவாயன்	(1) Serranus stoliczkæ. (2) S. pantherinus.
Pannimīn	பன்னிமீன்	(1) Lates calcarifer. (2) Cromileptes altivelis. (3) Serranus lanceolatus.
Pannisēttān	பன்னிசேத்தான்	(1) Lates calcarifer. (2) Cromileptes altivelis.
Pārai	பாறை	Caranx spp.
Parakkoravai	பரக்கொரவை	(1) Ophiocephalus gachua. (2) O. punctatus.
Paralā	பறளா	Coryphæna hippurus.
Paravetti	பறவெட்டி	Periopthalmus schlosseri.
Paravu	பரவு	Nuria danrica.
Paravukendai	பரவுகெண்டை	Rasbora daniconius.
Paruvakkōlā	பருவக்கோலா	(1) Exocœtus evolans. (2) E. pœcilopterus.
Paruvapelāchi	பருவபெலாச்சி	Tetrodon inermis.
Paruvasorā	பருவசொறு	Carcharias acutus.
Pāsimural	பாசிமுறல்	Hemirhamphus xanthopterus.
Pasindi	பசிந்தி	Drepane punctata.
Pasuvā	பசுவா	Priacanthus holocentrum.
Patna suttāṇṇākku	பட்னசுட்டாண்ணாக்கு	Pseudorhombus triocellatus.

Transliteration.	Tamil name.	Scientific name
Pāttai	பாட்டை	Eleotris muralis.
Pēārāl	பேயாருல்	Mastacembelus armatus.
Perunkilichal	பெருங்கிளிச்சல்	Cæsio chrysozona.
Peruntirukkai	பெருந்திருக்கை	Pteroplatea micrura.
Pēnavarai	பேநவரை	Upeneoides trgula.
Pēttai	பேத்தை	Tetrodon nigropunctatus.
Pillarinjān	பில்லரிஞ்சான்	Cirrhina reba.
Pillinjan	பில்லிஞ்சன்	(1) Saurus indicus. (2) Sphyræna jello.
Pillippannā	பில்லிப்பன்ன	Otolithus maculatus.
Pillippārai	பில்லிப்பாறை	Caranx speciosus.
Piluluvai	பில்உளுவை	Rhynchobatus aneylostomus.
Pīsukōlā	பீசுகோலா	Belone cancila.
Ponatti	பொனத்தி	Silundia gangetica.
Ponnāntalai	பொன்னாந்தலை	Pagrus spinifer.
Poruvā	பொருவா	Engraulis mystax.
Poruvākattalai	பொருவாகத்தலை	Sciæna vogleri.
Pottainettili	பொட்டைநெத்திலி	Engraulis tri.
Pōzhakkālā	போழக்காலா	Polynemus tetradactylus.
Pudukkansurā	புடுக்கன்சுறா	Carcharias ellioti.
Pūatirukkai	பூவாதிருக்கை	Aetobatis narinari.
Pullianpēttai	புள்ளியன்பேத்தை	Tetrodon stellatus.
Pullikalavā	புள்ளிகளவா	(1) Serranus hexagonatus. (2) S. maculatus.
Pullippannā	புள்ளிப்பன்ன	(1) Sciæna aneus. (2) Otolithus maculatus.
Pullitarattai	புள்ளிதரட்டை	Drepane punctata.
Pulliansurā	புள்ளியன் சுறா	Stegostoma tigrinum.
Pulliantirukkai	புள்ளியன்திருக்கை	Trygon uarnak.
Pūnkozhal	பூங்கொழல்	Seriolichthys bipinnulatus.
Purākkāsu	பூறாக்காசு	Etroplus maculatus.
Rāmamuzhian	ராமமுழியன்	Triacanthus strigilifer.
Sallikendai	சல்லிக்கெண்டை	Barbus carnaticus.
Salliūdakam	சல்லிஊடகம்	Gerres lucidus.
Sankkūditirukkai	சங்கூடி திருக்கை	Rhinoptera adspersa.
Sappekōlā	சப்பெகோலா	Hemirhamphus georgii.
Sāttamural	சாத்தமுறல்	Belone strongylura.
Sāyavelichai	சாயவெளிச்சை	Chela argentea.
Sēlkendai	சேல்கெண்டை	Labeo fimbriatus.
Seluppatti	செலுப்பட்டி	Solea ovata.
Sembadakkātirukkai	செம்படக்கா திருக்கை	Trygon walga.

Transliteration.	Tamil name.	Scientific name.
Sembarāmpanni	செம்பரும்பண்ணி	(1) Serranus pantherinus. (2) S. polleni.
Semmantirukkai	செம்மன்திருக்கை	Trygon bleekeri.
Semmārā	செம்மாரு	Lutjanus unimaculatus.
Sempārai	செம்பாறை	Caranx affinis.
Senganni	செங்கண்ணி	Lates calcarifer.
Senkadappārai	செங்கடப்பாறை	Caranx carangus.
Sennagarai	செந்நகறை	Synagris bleekeri.
Sennal	சென்னல்	Anabas scandens.
Sentumbi	செந்தும்பி	Pterois russellii.
Seppatirukkai	செப்பத்திருக்கை	Myliobatis nieuhofii.
Seppili	செப்பிலி	(1) Lutjanus argenti-malculatus. (2) L. roseus.
Serāmpāmbu	செரும்பாம்பு	(1) Muræna macrura. (2) Anguilla bengalensis.
Sēri	சேறி	Diagramma cinctum.
Sēttārāl	சேத்தாருல்	(1) Rhynchobdella aculeata. (2) Mastacembelus armatus.
Sevvālikendai	செவ்வாலிக்-கெண்டை	Barbus filamentosus.
Sīdai	சீடை	Clupea lile.
Sigappukalavā	சிகப்புக்களவாய்	Serranus sonnerati.
Sīlā	சீலா	Sphyræna jello.
Sīlai	சீலை	Callichrous bimaculatus.
Sīlaipparavu	சீலைப்பரவு	Danio malabaricus.
Sīlaivālai	சீலைவாளை	Callichrous bimaculatus.
Siraiyā	சிறையா	Mugil cœur.
Sombadakkā	சொம்படக்கா	Trygon zugei.
Sōnagankelutti	சோனகன்கெளுத்தி	Macrones punctatus.
Sōnagatirukkai	சோனகத்திருக்கை	Trygon uarnak.
Sōnagavālai	சோனகவாளை	Trichurus muticus.
Sottavālai	சொட்டவாளை	Callichrous bimaculatus.
Sūdai	சூடை	(1) Clupea fimbriata. (2) C. lile. (3) Pellona leschenaultii.
Sudumbu	சுதும்பு	Laetarius delicatulus.
Suduppunāmkāral	சுதுப்புநாம்காறல்	(1) Equula edentula. (2) E. insidiatrix.
Sūraimīn	சூறைமீன்	Thynnus thunnina.
Talampārai	தளம்பாறை	Caranx malabaricus.
Tannīrpēttai	தண்ணீர்ப்பேத்தை	Tetrodon nigropunctatus.
Tappakuttitirukkai	தப்பக்குட்டிதிருக்கை	(1) Pteroplatea micrura. (2) Myliobatis nieuhofii.
Tarali	தறளி	(1) Opisthopterus tartoor. (2) Raconda russeliana.
Ṭarattai	தரட்டை	Ephippus orbis.

Transliteration.	Tamil name.	Scientific name.
Taraūdān	தரஊடான்	Pentaprion longimanus.
Tatnānkāral	தட்ணுங்காறல்	Equula bindus.
Tadiyansīlā	தடியன்சீலா	Sphyræna obtusata.
Tāzhankālā	தாழன்காலா	Polynemus indicus.
Tāzhankīli	தாழன்கீளி	Therapon buadrilineatus.
Tēli	தேளி	Saccobranchus fossilis.
Tēnavarai	தேநவரை	Upeneoides bensasi.
Tēngappārai	தேங்காப்பாறை.	(1) Caranx kalla. (2) C. nigrescens. (3) C. armatus.
Tēntalai	தேந்தலை.	Pimelepterus cinerascens.
Tērakam	தேரகம்.	Atherina forsakalii.
Tērankuni	தேரங்குணி	Engraulis commersonianus.
Terukkuttuvā	தெருக்குத்துவா	(1) Clupea kunzei. (2) Pellona indica.
Timilai	திமிலை.	(1) Narcine timlei. (2) Astrape dipterygia.
Tiraliūdakam	திரளிஊடகம்.	Gerres oyena.
Tirappārai	திறப்பாரை	Caranx oblongus.
Tirukkai	திருக்கை	Narcine timlei.
Tiruvan	திருவன்	Mugil parsia.
Tiruvankōlā	திருவன்கோலா	Hemirhamphus limbatus
Tōkkāral	தோக்காருல்	Pristipoma hasta.
Tōlpārai	தோல்பாறை	(1) Chorinemus lysan. (2) C. toloo.
Tūkkunāsi	தூக்குநாசி	(1) Trachynotus russellii. (2) T. ovatus.
Tumbi	தும்பி	Pterois russellii.
Tumbili	தும்பிளி	Saurida tumbil.
Tūrādikattalai	தூராடிகத்தளை	Sciæna belangeri.
Udakam	ஊடகம்	(1) Gerres filamentosus. (2) Pristipoma furcatum
Uduppātti	உடுப்பாத்தி	Etroplus suratensis.
Ūlān	ஊளான்	Crenidens indicus.
Ullā	உள்ளா	Sphyræna acutipinnis.
Ullam	உள்ளம்	(1) Clupea ilisha. (2) C. toli.
Uluvai	உளுவை	(1) Saurida tumbil. (2) Gobius gutum. (3) G. giuris.
Umaichi	ஊமைச்சி	Ostracion cornutus.
Umaikilātti	ஊமைகிளாத்தி	Monacanthus scriptus.
Undekelutti	உண்டெக்கெளுத்தி	Arius nella.
Unguni	உங்குணி	Cæsio chrysozona.
Urikkutti	உரிக்குட்டி	(1) Echeneis naucrates. (2) E. brachyptera.
Uruppātti	உருப்பாத்தி	(1) Platycephalus scaber (2) P. insidiator.

Transliteration.	Tamil name.	Scientific name.
Vālai	வாளை	(1) Chirocentrus dorab (2) Wallago attu. (3) Trichiurus savala.
Vālankandal	வாலன்கண்டல்	Synagris striatus.
Valuvansorā	வளுவன்சொறு	Galeocerdo rayneri.
Valvaditirukkai	வள்வாடிதிருக்கை	Rhinoptera javanica.
Vāniyanporuvā	வாணியனபொருவா	(1) Engraulis malabaricus. (2) E. hamiltonii.
Vanjaram	வஞ்சரம்	(1) Cybium interruptum. (2) C. guttatum
Vannātti	வண்ணாத்தி.	(1) Barbus ticto. (2) Chætodon collaris.
Varikkanōrā	வரிக்கண்ஓறு	Teuthis concatenata.
Varikkāral	வறிக்காறல்	Equula dussumieri.
Varikkattalai	வரிக்கத்தளை	(1) Lutjanus sebæ. (2) Sciæna maculata.
Varikkīchān	வரிக்கீச்சான்	Lutjanus kasmira.
Varikkōlā	வரிக்கோலா	Hamirhamphus far.
Varippārai	வரிப்பாறை	Caranx affinis.
Varnanachuzhi	வர்ணநச்சுழி	Percis pulchella.
Vauvāl	வெளவால்	Stromateus niger.
Vayirrankelutti	வயிற்றங்கெளுத்தி	(1) Arius parvipinnis. (2) A. thalassinus.
Vazhukkaikelutti	வழுக்கைக்கெளுத்தி	Silundia gangetica.
Vēlāmīn	வேளாமீன்	Pristís cuspidatus.
Velāsurā	வேளாசுறு	Pristis zysron.
Velichaikendai	வெளிச்சைக்கெண்டை	(1) Chela argentea. (2) C. clupeoides.
Vellaikattalai	வெள்ளைசத்தளை	(1) Sciæna miles. (2) S. albida.
Vellaikattāzhai	வெள்ளைகத்தாழை	Sciæna coitor.
Vellaikelutti	வெள்ளைக்கெளுத்தி	Macrones cavasius.
Vellaikichili	வெள்ளைகிச்சிலி	Sciæna coitor.
Vellaikōlsurā	வெள்ளைக்கோல்சுறு	Hemigaleus balfouri.
Vellaimattuvā	வெள்ளைமட்டுவா	Chrysophrys sarba.
Vellaitumbi	வெள்ளைதும்பி	Apistus carinatus.
Vellaivauvāl	வெள்ளைவெளவால்	Stromateus cinereus.
Vellārani surā	வெள்ளாரணிசுறு	Scyllium capense.
Vellarinjakendai	வெள்ளரிஞ்சகெண்டை	Labeo boga.
Vellisā	வெள்ளிசா	Mugil borneensis.
Velrāmīn	வெள்றுமீன்	Cybium guttatum.
Vengannu	வெங்கண்ணு	Pellona brachysoma.
Vennaippārai	வெண்ணைப்பாறை	Caranx ire.
Vilamin	விளமீன்	Lutjanus spp. Lethrinus spp.
Vilāngu	விலாங்கு	Anguilla bengalensis.
Virāl	விறல்	Ophiocephalus striatus.